CURRICULUM STRUCTURE

UG: B.E.

Honors/Minor degree programs

REVISION: FRCRCE-1-24

Effective for Academic Year 2024-25 & 2025-26
Board of Studies Approval:
Academic Council Approval:

Dr. DEEPAK BHOIR
Dean Academics

DR. SURENDRA RATHOD
Principal

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Preamble:

Greetings and congratulations to all the education partners Fr Conceicao Rodrigues College of Engineering for getting autonomous status to the college from the year 2024-25. University Grant Commission vide letter No. F. 2-10/2023(AC-Policy) dated 23rd Nov 2023 conferred the autonomous status to Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai 400050 affiliated to University of Mumbai for a period of 10 years from the academic year 2024-2025 to 2033-2034 as per clause 7.5 of the UGC (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations,2023. We look towards autonomy as a great opportunity to design and implement curriculum sensitive to needs of Learner, Indian Society and Industries.

Government of Maharashtra has also directed Autonomous Colleges to revise their curriculum in line with National Education Policy (NEP) 2020 through Government Resolution dated 4th July 2023. We commit to ourselves to the effective implementation of UGC Regulations and NEP 2020 in its spirit.

Various steps are taken to transform teaching learning process to make learning a joyful experience for students. We believe that this curriculum will raise the bar of academic standards with the active involvement and cooperation from students, academic and administrative units. For third year students, innovative assessment practices are being adopted to improve learning outcomes.

Honours and Minor Degree Eligibility Criteria for Students:

      i. Following is the eligibility criteria for students opting the Honours/ Minor Degree program:

            a. Students with no backlog in semester I, II, and III

            b. The CGPI (based on semester I, II, and III) of the students must be 6.75 and above

            c. For direct second year (DSE) admitted students - No backlog in semester III and CGPI must be 6.75 and above

    ii) Each eligible student can opt for maximum one Honour's or one Minor Programs at any time.

    iii) However, it is optional for learners to take Honours/Minor degree program.

    iv) The Honours/ Minor degree program can be opted only during regular engineering studies

    v) The student shall complete the Honours/ Minor degree program in stipulated four semesters only.

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Curriculum Structure for Honors / Minor Programs at Fr CRCE for A.Y. 2024-25 and A.Y. 2025-26

Notes:

Learners will have the following options to earn **B. E. in ....(regular) Engineering with Honours/Minor in .... (specialization)**

Sr. No.	Honors/Minor degree programs	Programs who can offer this Honours Degree Program	Programs who can offer this as Minor Degree program
1	Internet of Things	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science 4. Mechanical Engineering	--
2	Artificial Intelligence and Machine Learning	1. Computer Engineering 2. Electronics and Computer Science	Mechanical Engineering
3	Data Science	1. Computer Engineering 2. Electronics and Computer Science 3. Mechanical Engineering	
4	Blockchain	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science	Mechanical Engineering
5	Cyber Security	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science	Mechanical Engineering
6	Robotics	Mechanical Engineering	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science
7	3D Printing	Mechanical Engineering	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science

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Credit requirements for different options of the Degrees:

Degree/SEM	I	II	III	IV	V	VI	VII	VIII	Total
B. E.	18	20	22	23	23	22	22	22	172
B.E. with Honors/Minors	18	20	22	23	23+4*	22+4*	22+6*	22+4*	172+18*=190

Optional Credits

SEM-V, VI, VII & VIII										
Course Code	Course Name		Contact Hours	Examination Marks					Credits	
				ISE1	MSE	ISE2	ESE	Total	Points	Total
HMC 501	HONOR/MINOR Course 1 Title	TH	4	20	30	20	30	100	4	4
HMC 601	HONOR/MINOR Course 2 Title	TH	4	20	30	20	30	100	4	4
HMC 701	HONOR/MINOR Course 3 Title	TH	4	20	30	20	30	100	4	4
HML 701	HONOR/MINOR Skill Lab 3 Title	PR	4	20	-	30	-	50	2	2
HMC 801	HONOR/MINOR Course 4 Title	TH	4	20	30	20	30	100	4	4
Total			TH:TU:PR 12:0:4=16			-	-	450	-	18

Internet of Things (IoT)

SEM-V, VI, VII & VIII										
Course Code	Course Name		Contact Hours	Examination Marks					Credits	
				ISE1	MSE	ISE2	ESE	Total	Points	Total
HIoTC501	IoT Sensor Technologies	TH	4	20	30	20	30	100	4	4
HIoTC601	IoT System Design	TH	4	20	30	20	30	100	4	4
HIoTC701	Dynamic Paradigm in IoT	TH	4	20	30	20	30	100	4	4
HIoTSBL701	Interface & Programming with IoT Lab	PR	4	20	-	30	-	50	2	2
HIoTC801	Industrial IoT	TH	4	20	30	20	30	100	4	4
Total			TH: TU:PR 12:0:4=16			-	-	450	-	18

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HIoTC501	IoT Sensor Technologies	4	--	0	4	--	--	4
		Examination Scheme						
			ISE-I	MSE	ISE-II	ESE		Total
		Theory	20	30	20	100 (30% weightage)		100

Pre-requisite Course Codes	1. Basics of Electrical and Electronics Engineering (FEC105) 2. Applied Mechanics (FEC104) 3. Applied Physics, Applied Chemistry (FEC102, FEC103, FEC202, FEC203)	
Course Outcomes	At the End of the course students will be able to :	
	CO1	Understand the sensing mechanism and structural details of sensors.
	CO2	Explain principles and working of the sensors.
	CO3	Evaluate the performance of various types of sensors.
	CO4	Select the sensor suitable to system requirements.
	CO5	Interface the sensors with microcontrollers and Arduino.
	CO6	Understand the current state of the art in sensor technology.

Module No.	Unit No.	Topics	Hrs.
1.Sensor Fundamental s and Properties	1.1	Introduction to IoT, Need for sensors in IoT, Data Acquisition – sensor characteristics	8
	1.2	Electric charges, fields, potentials – capacitance – magnetism – inductance – resistance – piezoelectric – pyro-electric – Hall effect thermoelectric effects – sound waves – heat transfer – light – dynamic models of sensors.	
	1.3	Need of actuators, all types of actuators and their working. Identification of sensor and actuator for real-time application	
	1.4	**Self-learning Topics:** IoT Systems, Transfer function and modelling of	

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		sensors	
2. Optical, radiation and Displacement sensors	2.1	Photo-sensors: Photodiode, phototransistor and photo resistor, imaging sensors, UV detectors, Basic Characteristics of radiation sensors, Thermal infrared sensors, X-ray and Nuclear Radiation Sensors, Fibre Optic Sensors, Capacitive and Inductive Displacement Sensor, Electromagnetism and Inductance, Magnetic Field Sensors	8
	2.2	**Self-learning Topics:** Optical sources and detectors, Sensors based on polymer optical fibers, Micro-structured and solid fibers	
3. Presence, force, Pressure, Flow Sensors	3.1	Potentiometric Sensors, Piezoresistive Sensors, Capacitive Sensors for presence, Inductive and Magnetic Sensors, Strain gages, Pressure sensitive films, piezoelectric force sensor, Piezoelectric Cables, Concept of Pressure, Mercury Pressure Sensor, Bellows, Membranes, and Thin Plates, Piezo resistive Sensors, Capacitive Sensors, VRP Sensors, Optoelectronic Pressure Sensors, Indirect Pressure Sensor, Vacuum Sensors, Basics of Flow Dynamics, Pressure Gradient Technique, Thermal Transport Sensors, Ultrasonic Sensors, Level Sensors	9
	3.2	**Self-learning Topics:** Vibration energy harvesting with Piezoelectric, MEMS systems. Develop a sensor system for force measurement using piezoelectric transducer. Develop Resistance Temperature Detector	
4. Humidity, Moisture, Chemical and Biological Sensors	4.1	Microphones: Characteristics, Resistive, condenser, Electret, Optical, Pizoelectric, Dynamic	8
	4.2	Concept of humidity, Capacitive Humidity Sensors, Resistive Humidity Sensors, Thermal Conductivity Sensors, Optical Hygrometers, Oscillating Hygrometer, Soil Moisture	
	4.3	Chemical Sensor Characteristics, Electrical and Electrochemical Sensors, Photoionization Detectors, Physical Transducers, Spectrometers, Thermal Sensors, Optical Transducers, Multi-sensor Arrays	
	4.4	Artificial Microsystems for Sensing Airflow, Temperature, and Humidity by Combining MEMS and CMOS Technologies	
	4.5	**Self-learning Topics:** Biosensors for biomedical applications	

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5. Interface Electronic Circuits	**5.1**	Introduction, Signal Conditioners, Sensor Connections, Excitation Circuits, Analog to Digital Converters, Integrated Interfaces, Data Transmission, Noise in Sensors and Circuits, Batteries for Low-Power Sensors, study the properties of LDR	**8**
	5.2	Types of Single board computers, various sensor interfacing with Arduino, Embedded C Programming. data communication protocol interfacing,	
	5.3	Build a simple LED light intensity controller, Linux on Raspberry Pi, Interfaces, and Programming.	
	5.4	**Self-learning Topics:** Python Programming to interface sensors	
6. Current Trends in sensors and Technology	**6.1**	Smart Sensors: Introduction, Primary sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface	**9**
	6.2	The Automation Sensor Technologies: Introduction, Film Sensors, Thick Film Sensors, Thin Film Sensors, Semiconductor IC Technology—Standard Methods, Microelectromechanical Systems (MEMS), Nano-sensors	
	6.3	Sensor Applications: Onboard Automobile sensors, Home appliances sensors, Aerospace Sensors, Sensors for Environmental Monitoring	
	6.4	**Self-learning Topics:** Energy Harvesting, Self-powered Wireless Sensing in ground, Ground penetrating sensors	
		Total	**50**

Course Assessment:

Theory:

ISE-I **:** Assignment for 20 marks

ISE-II : TPS activity on sensor circuitry requirement for the IOT project for 20 marks

MSE **:** Written examination on 50% syllabus for 30 marks

ESE **:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

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Recommended Books:

1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York
2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland
3. D. Patranabis, "Sensor and Transducers" (2e) Prentice Hall, New Delhi, 2003
4. Vijay Madisetti, Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014
5. Edited by Qusay F Hasan, Atta ur rehman Khan, Sajid A madani, "Internet of Things Challenges, Advances, and Application", CRC Press
6. Mercel Dekker, "Triethy HL - Transducers in Electronic and Mechanical Designs", 2003
7. Gerd Keiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, New Delhi
8. John G Webster, Halit Eren, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press, Taylor and Fransis Group, New York
9. Adrian McEwen, "Designing the Internet of Things", Wiley Publishers, 2013, ISBN: 978-1-118-43062-0
10. Nathan Ida, "Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction", Second Edition, IET Control, Robotics and Sensors Series 127, 2020

Online References:

1. https://nptel.ac.in/courses/108/108/108108123/

2. https://nptel.ac.in/courses/108/108/108108098/

3. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee41/

4. https://nptel.ac.in/courses/108/106/108106165/

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HIoTC601	**IoT System Design**	4	--	–	4	--	–	4
		Examination Scheme						
			ISE-I	MSE	ISE-II	ESE		Total
		Theory	20	30	20	100 (30% weightage)		100

Pre-requisite Course Codes	Basics of Embedded System, IoT Sensors, Digital design
	(Prerequisite syllabus should not be considered for paper setting)
Course Outcomes	At the End of the course students will be able to :
	CO1	Explain principles, concepts, and technologies for the internet of things.
	CO2	Identify various building blocks of IoT system
	CO3	Analyze and evaluate various networking and communication protocols used in IoT system
	CO4	Select appropriate interface for given application
	CO5	Design and analyze IoT system for given application
	CO6	Evaluate performance of given IOT System

Module No.	Unit No.	Topics	Hrs.
1. **Overview of IoT System**	**1.1**	What is an IoT System? IoT Impact, Current Trends in IoT, IoT Challenges,	**6**
	1.2	Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack	

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	1.3	How are IoT Systems different from traditional system Values and Uses of IoT Functional View and Infrastructure view of IoT Systems	
	1.4	**Self-learning Topics:** Understanding the Issues and Challenges of a More Connected World	
2. **Networking Protocols**	2.1	OSI Model for the IoT/M2M System Lightweight M2M	**8**
	2.2	Communication Protocols, Internet based Communications, IP addressing in IoT, Network Model, TCP & UDP, Client-Server architecture	
	2.3	**Self-learning Topics:** How to choose correct protocol for our network	
3. **Communica-tion Protocols**	3.1	IoT Edge to Cloud protocols: HTTP, REST APIs, WebSocket, MQTT, COAP, Comparison of Protocols, M2M Communication Protocols, Bluetooth BR/EDR and Bluetooth low energy.	**10**
	3.2	RFID IoT System , RFID IoT Network Architecture, ZigBee IP/ZigBee SE2.0, Wifi(WLAN), Message Communication protocols for connected devices	
	3.3	Data exchange formats: JSON & XML, Node-Red, Flow control using Node- Red, learning the different nodes of Node-RED for implementing the Communication Protocols	
	3.4	**Self-learning Topics:** Types of Communication	
4. **Sensor Interfaces**	4.1	Digital Interfaces: UART, Serial Peripheral Interface (SPI), I2C (Inter-Integrated Circuit), Controller Area Network (CAN), Middleware Technologies, Communication Protocols and Models. Practical Components Programming with interface in Arduino, MBed and Raspberry Pi	**10**
	4.2	**Self-learning Topics:** Smart sensors interfaces	
5. **Design principles for prototyping**	5.1	Design solution for ubiquitous and utility, Interface design for user experience, Designing for data privacy	**8**
	5.2	Interfacing – Apps & Webs, Designing for Affordability, Cost v/s Ease of Prototyping, Prototypes and Production,	

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	5.3	Selection of embedded platform, Prototype and Mass personalization, Open Source v/s Closed Source ,Amplification and Signal Conditioning- Integrated Signal Conditioning- Digital conversion- MCU Control, MCUs for Sensor Interface- Techniques and System Considerations- Sensor Integration	
	5.4	**Self-learning Topics:** Principles for Prototyping and moving towards Product Development	
6. **IoT case studies**	6.1	Arduino Programming for Ethernet and WiFi connectivity, Networking and Data logging with Raspberry Pi	**8**
	6.2	Applications: Agriculture, Medical, Fire detection, Air pollution prediction, Earthquake early detection; for smart environmental care, smart travelling, Home Automation	
	6.3	**Self-learning Topics**: IoT enabled Business solution in Supply Chain	
		Total	**50**

Course Assessment:

Theory:

    ISE-I : Quiz / group discussion for 20 marks

    ISE-II : Oral examination for 20 marks

    MSE   : Written examination on 50% syllabus for 30 marks

    ESE : Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Recommended Books:

1. S. Misra, A. Mukherjee, and A. Roy, "Introduction to IoT", Cambridge University Press, 2020
2. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", John Wiley and Sons Ltd, UK, 2014.
3. Milan Milenkovic, "Internet of Things: Concepts and System Design", Springer International Publishing, May 2020
4. Dr. Raj Kamal, "Internet of Things: Architecture and Design Principles", McGraw Hill Education

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5. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things"

6. N. Ida, "Sensors, Actuators and Their Interfaces", Scitech Publishers, 2014.

7. Editors OvidiuVermesan Peter Friess, "Internet of Things: From Research and Innovation to Market"

8. Dr. Guillaume Girardin, Antoine Bonnabel, Dr. Eric Mounier, "Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024", Yole Development Copyrights, 2014

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HIoTC701	Dynamic Paradigm in IoT	4	--	–	4	--	–	4
		Examination Scheme						
			ISE-I	MSE	ISE-II	ESE		Total
		Theory	20	30	20	100 (30% weightage)		100

Pre-requisite Course Codes	Basics of Cloud Computing, Basics of Machine learning and primitives of cryptography	
Course Outcomes	At the End of the course students will be able to:	
	CO1	Identify the need for the cloud in IoT deployment and describe different Cloud provider's architecture.
	CO2	Use and correlate machine learning techniques on IoT Data.
	CO3	Apply IoT analytics and data visualization.
	CO4	Recognize the use of Fog Computing in the Internet of things.
	CO5	Explain the need of security measures in the Internet of Things.
	CO6	Apply the knowledge of Dev-ops in IoT applications.

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Module No.	Unit No.	Topics	Hrs.
1. **IoT and CLOUD**	**1.1**	Cloud Computing Concept, Grid/SOA and Cloud Computing, Cloud Middleware NIST's SPI Architecture and Cloud Standards, The Cloud of Things-- The Internet of Things and Cloud Computing, The Cloud of Things Architecture-- Four Deployment Models, Vertical Applications, Fifteen Essential Features, Four Technological Pillars, Three Layers of IoT Systems, Foundational Technological Enabler Cloud Providers and Systems -- Microsoft Azure IoT, Amazon Web Services, Google's cloud IoTs	**10**
	1.2	**Self-learning Module:** IBM Watson Cloud	
2. **IoT and Machine Learning**	**2.1**	Advantages of IoT and Machine Learning Integration, Implementation of Supervised Algorithm- Regression (Linear and Logistic), SVM for IoT-Neural Network on case study: Agriculture and IoT, Smart Home etc.	**6**
	2.2	**Self-Learning Module:** Regression, SVM	
3. **IoT and Data Analytics**	**3.1**	Defining IoT Analytics, IoT Analytics challenges, IoT analytics for the cloud-Microsoft Azure overview– Strategies to organize Data for IoT Analytics, Linked Analytics Data Sets, Managing Data lakes, The data retention strategy. Communicating with Others- Visualization and Dash boarding- Designing visual analysis for IoT data, creating a dashboard –creating and visualizing alerts	**8**
	3.2	**Self-learning Topics:** Study real time case study on IoT Analytics	

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4. IoT and Fog Computing	4.1	Fog computing Basics, The Hadoop philosophy for Fog computing, Fog Computing versus Edge Computing versus cloud computing, Open Fog Reference Architecture Application services-- Application support, Node management and software backplane, Hardware virtualization, Open Fog node security, Network Accelerators Compute, Storage Hardware platform infrastructure, Protocol abstraction, Sensors, actuators, and control systems, Fog Topology	8
	4.2	**Self-learning Module:** Amazon Green grass and Lambda (implementation)	
5. IoT and it's Security	5.1	Cyber security vernacular Attack and threat terms, Defense terms, Anatomy of IoT cyber attacks – Mirai, Stuxnet, Chain Reaction, Physical and hardware security, Root of Trust, Key management and trusted platform modules, Processor and memory space, Storage security, Network stack – Transport Layer Security, Software defined perimeter, Software-Defined Perimeter architecture	8
	5.2	**Self-learning Module:** OWASP-Existing Security attacks and its prevention methods.	
6. IoT and Devops	6.1	Introduction to DevOps, DevOps application - business scenarios, DevOps process-- Source Code Management (SCM), Code review, Configuration Management, Build management, Artifacts repository management, Release management, Test automation, Continuous integration, Continuous delivery, Continuous deployment, Infrastructure as Code, Routine automation, Key application performance monitoring/indicators, DevOps frameworks--DevOps maturity life cycle, DevOps maturity map, DevOps progression framework/readiness model, DevOps maturity checklists, Agile framework for DevOps process projects, Agile ways of development	10
		Tool for IoT—Chef and Puppet, Setting up Chef and Puppet, Multi-tier Application Deployment, NETCONF-YANG Case Studies- Steps for IoT device management with NETCONF-YANG, Managing Smart irrigation IoT system with NETCONF-YANG, Managing Home Intrusion Detection IoT system with NETCONF-YANG	

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	6.2	**Self-learning Topics:** Compare different tool of IoT	
		Total	**50**

Course Assessment:

Theory:

ISE-I : Project requirement gathering in (IEEE SRS format) for the IOT project problem for 20 marks

ISE-II : Design methodology for the given IOT project problem for 20 marks

MSE   : Written examination on 50% syllabus for 30 marks

ESE : Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Recommended Books:

1. Honbo Zhou, "The Internet of Things in the Cloud A Middleware Perspective", – CRC Publication
2. Andrew Minteer, "Analytics for the Internet of Things (IoT)", Packt Publication 2017
3. Arshdeep Bagha, Vijay Medisetti, "Internet of Things- Hands on Approach", Published by Arshdeep Bagha and Vijay Medisetti, 2014
4. Sricharan Vadapalli, "Hands-on DevOps", Packt Publication, 2017
5. Perry Lea, "Internet of things For Architects", Packt Publication, 2018
6. Gautam Shroff, "Enterprise Cloud Computing", Cambridge, 2010
7. Raj Kumar Buyya, Christian Vecchiola,S. Thamarai Selvi, "Mastering Cloud Computing-Foundations and Applications Programming", MK Publication, 2013
8. Peter Harrington, "Machine Learning in Action", DreamTech Press
9. Ethem Alpaydın, "Introduction to Machine Learning", MIT Press
10. Agus Kurniawan,"Learning AWS IoT- Effectively Manage Connected Devices on the AWS Cloud Using Services Such as AWS Greengrass, AWS Button, Predictive Analytics and Machine Learning", Packt Publication, 2018
11. Joakim Verona, "Practical Dev-Ops", Packt Publication, 2016

Online References:

1. https://hub.packtpub.com/25-datasets-deep-learning-iot/

2. https://data.world/datasets/iot

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3. https://dashboard.healthit.gov/datadashboard/data.php

4. https://www.data.gov/

5. https://dev.socrata.com/data/

6. https://www.kaggle.com/

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HIoTSBL701	**Interfacing & Programming with IoT Lab. (SBL)**	--	--	4	--	--	2	2
		Examination Scheme						
			ISE-I	MSE	ISE-II	ESE	Total	
		Lab.	20	--	30	--	50	

Pre-requisite Course Codes	IoT introduction course: Basics of IoT, Introduction to Embedded systems Hardware & Software Requirements	
Course Outcomes	At the End of the course students will be able to:	
	CO1	Adapt different techniques for data acquisition using various IoT sensors for different applications.
	CO2	Demonstrate the working of actuators based on the collected data.
	CO3	Use different IoT simulators and correlate working of IoT protocols.
	CO4	Adapt different techniques for Integrating IoT services to other third-party Clouds.
	CO5	Execute DevOps methodologies for continuous integration and continuous deployment of IoT application.
	CO6	Implement IoT protocols like MQTT for communication to realize the revolution of internet in mobile devices, cloud and sensor networks.

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Experiment No.	Title of Experiment
1	To study and implement interfacing of different IoT sensors with Raspberry Pi/Arduino/ModeMCU
2	To study and implement interfacing of actuators based on the data collected using IoT sensors. (like LED switch ON/OFF, stepper word)
3	To study and demonstrate Contiki OS for RPL (like Create 2 border router and 10 REST clients, Access border router from other network (Simulator))
4	To study and demonstrate use of IoT simulators (like Beviswise) on any real time device (LED/stepper motor)
5	Select any one case study (in a group of 2-3) and perform the experiments 5 to 10. The sample case studies can be as follows: i) Smart home automation system ii) Healthcare management system iii) Smart traffic management system & so on… Write a program on Raspberry Pi to push and retrieve the data from cloud like thingspeak, thingsboard, AWS, Azure etc.
6	To install MySQL database on Raspberry Pi and perform basic SQL queries for analysis data collected.
7	To study and implement IoT Data processing using Pandas
8	To study and implement Continuous Integration using Jenkins on IoT data and also perform interfacing of Raspberry Pi into Jenkins.
9	To study and implement Continuous Deployment (Infrastructure as a code) for IoT using Ansible.
10	To study MQTT Mosquitto server and write a program on Arduino/Raspberry Pi to publish sensor data to MQTT broker.

Laboratory Assessment:

   ISE-I : 5 experiments for 50 marks

   ISE-II : 5 experiments for 50 marks

Recommended Books:

1. Jake VanderPlas,"Python Data Science Handbook", O'Reilly publication, 2016
2. Joakim Verona, "Practical DevOps", PACKT publishing, 2016
3. Honbo Zhou, "The internet of things in the cloud", CRC press, Taylor and Francis group, 2012

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4. Perry Lea, "Internet of things for architects", PACKT publishing, 2018

Online Resources:

1. https://spoken-tutorial.org/watch/Arduino/Introduction+to+Arduino/English/

2. https://pythonprogramming.net/introduction-raspberry-pi-tutorials/

3. https://iotbytes.wordpress.com/basic-iot-actuators/

4. http://www.contiki-os.org/

5. https://www.bevywise.com/iot-simulator/

6. https://mqtt.org/

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		4	--	–	4	--	–	4
HIoTC801	**Industrial IoT**	**Examination Scheme**						
		Theory	ISE-I	MSE	ISE-II	ESE		Total
		Theory	20	30	20	100 (30% weightage)		100

Pre-requisite Course Codes	IOT Concepts, Sensor Technology, IOT Stack and Protocols, Design IoT systems, WSN etc.	
Course Outcomes	At the End of the course students will be able to :	
	CO1	Understand the concepts of Industry 4.0 and IIOT.
	CO2	Understand reference Architecture of IIOT.
	CO3	Understand Industrial Data Transmission and Industrial Data Acquisition.
	CO4	Understand middleware and WAN technologies in IIOT.
	CO5	Understand the concepts of Blockchain and Security in IIOT.
	CO6	Apply security in IIOT applications.

Module No.	Unit No.	Topics	Hrs.
1. Introduction	**1.1**	Overview of Industry 4.0 and Industrial Internet of Things, Industry 4.0: Industrial Revolution: Phases of Development, Evolution of Industry 4.0, Environment impacts of industrial revolution, Industrial Internet, Basics of CPS, CPS and IIOT, Design requirements of Industry 4.0, Drivers of Industry 4.0, Sustainability Assessment of Industries, Smart Business Perspective, Cyber security, Impacts of Industry 4.0, Industrial Internet of Things: Basics, IIOT and Industry 4.0	**6**

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	1.2	Industrial Internet Systems, Industrial Sensing, Industrial Processes, IIOT Challenges – Identifying Things within the internet, Discovering Things and the Data they possess, Managing massive amount of data, Navigating Connectivity Outages, IIOT Edge - Leveraging the Power of Cloud Computing, Communicating with Devices on the Edge, Determining a Request/Response Model	
	1.3	**Self-learning Topics:** Study real time IIoT challenges in industry	
2. **IIOT** **Reference Architecture**	2.1	The IIC Industrial Internet Reference Architecture - Industrial Internet Architecture Framework (IIAF), Industrial Internet Viewpoints - Functional, Operational, Information Application and Business Domain of IIAF. The Three-Tier Topology, Key Functional Characteristics of Connectivity. Software Architectural Style for the Industrial Internet of Things - Software Architecture Practice, Advanced Architectural Styles, Systems of Systems, Challenges of Software Engineering in IIoT, Principles for Software Architecture design in IIoT, The Principled Decomposition, The Architectural Style	8
	2.2	**Self-learning Topics:** Study IIoT Architecture	
3. **Industrial Data Transmission and Industrial Data Acquisition**	3.1	Introduction, (Features and Components of - Foundation Fieldbus, Profibus, HART,Interbus, Bitbus, CC-Link, Modbus, Batibus, DigitalSTROM, Controller Area Network, DeviceNet, LonWorks, ISA 100.11a, Wireless HART, LoRa and LoRaWAN) NB-IoT, IEEE 802.11AH, Distributed Control System, PLC, SCADA	10
	3.2	**Self-learning Topics:** Study SCADA, PLC in detail	
4. **IIOT** **Middleware and WAN Technologies**	4.1	(From Industrial Application Perspective) Examining Middleware Transport Protocols (TCP/IP, UDP, RTP, CoAP), Middleware Software Patterns (Publish Subscribe Pattern, Delay Tolerant Networks), Software Design Concepts – Application Programming Interface – A Technical Perspective, Why Are APIs Important for Business? Web Services,IIOT Middleware Platforms – Middleware Architecture	10
	4.2	IIOT WAN Technologies and Protocols - IIoT Device Low-Power WAN Optimized Technologies for M2M, SigFox, LoRaWAN,nWave, Dash7 Protocol, Ingénue RPMA, Low Power Wi-Fi, LTE Category-M, Weightless, Millimeter Radio	
	4.3	**Self-learning Topics:** Study different IIoT Middleware and WAN Technologies	

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5. **IIOT** **Blockchain and Security**	**5.1**	Blockchains and cryptocurrencies in IoT, Bitcoin (blockchain- based), IOTA- distributed ledger (directed a cyclical graph-based), Government regulations and intervention, US Congressional Bill – Internet of Things (IoT) Cyber security Improvement Act of 2017, Other governmental bodies, IoT security best practices, Holistic security		**8**
	5.2	**Self-learning Topics:** Case study on IIoT, Block chain and Security		
6. **IIOT** **Applications and Securities**	**6.1**	The IoT Security Lifecycle- The secure IoT system implementation lifecycle, Implementation and integration, IoT security CONOPS document, Network and security integration, System security verification and validation (V&V), Security training, Secure configurations, Operations and maintenance, Managing identities, roles, and attributes, Security monitoring, Penetration testing, Compliance monitoring, Asset and configuration management, Incident management, Forensics, Dispose, Secure device disposal and zeroization, Data purging, Inventory control, Data archiving and records management		**8**
	6.2	Securing the Industrial Internet - Security in Manufacturing, PLCs and DCS, Securing the OT (Operation Technology), Network, System Level: Potential Security Issues, Identity Access Management		
	6.3	Develop New Business Models – Adopt Smart Architectures and Technologies, Sensor-Driven Computing, Industrial Analytics, Intelligent Machine Applications, Transform the Workforce		
	6.4	Case Studies –Healthcare Applications in Industries – Challenges associated with Healthcare, Introduction, Smart Devices, Advanced technologies used in healthcare. Inventory Management and Quality Control – Introduction, Inventory Management and IIOT, Quality Control in Manufacturing Industry, Automotive Industry and Mining Industry		
	6.5	**Self-learning Topics:** Study real time IIoT application		
			Total	**50**

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Course Assessment:

ISE-I : 50% implementation of the IOT project for 20 marks

ISE-II : 100% implementation of the IOT project for 20 marks

MSE   : Written examination on 50% syllabus for 30 marks

ESE : Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Recommended Books:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", (Apress)
2. Sudip Misra, Chandana Roy And Anandarup Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0" CRC Press (Taylor & Francis Group)
3. Rajkumar Buyya, Amir Vahid Dastjerdi, "Internet of Things Principles and Paradigms", ELSEVIER Inc.
4. Perry Lea, "Internet of things For Architects", Packt Publication,2018
5. Brian Russell, Drew Van Duren, "Practical Internet of Things Security", Packt Publishing
6. Tony Paine,"Industrial Internet of Things and Communications at the Edge", Kepware Technologies
7. Hasan Derhamy, "Architectural Design Principles For Industrial Internet of Things", Luleå University of Technology, Graphic Production

Online References:

1. https://onlinecourses.nptel.ac.in/noc20_cs69/preview

2. https://www.coursera.org/specializations/developing-industrial-iot

3. https://www.coursera.org/lecture/advanced-manufacturing-enterprise/the-industrial-internet-of-things-iiot-59EvI

4. https://www.coursera.org/lecture/industrial-iot-markets-security/segment-12-blockchains-l4aG9

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Artificial Intelligence and Machine Learning (AI&ML)

SEM-V, VI, VII & VIII										
Course Code	Course Name		Contact Hours	Examination Marks					Credits	
				ISE1	MSE	ISE2	ESE	Total	Points	Total
HAIMLC501	Mathematics for AI & ML	TH	4	20	30	20	30	100	4	4
HAIMLC601	Game Theory using AI & ML	TH	4	20	30	20	30	100	4	4
HAIMLC701	AI&ML in Healthcare	TH	4	20	30	20	30	100	4	4
HAIMLSBL701	AI&ML in Healthcare: Lab	PR	4	20	-	30	-	50	2	2
HAIMLC801	Text, Web and Social Media Analytics	TH	4	20	30	20	30	100	4	4
	Total		TH:TU:PR 12:0:4=16			-	-	450	-	18

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
HAIMLC501	**Mathematics for AI&ML**	Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		--	
Course Outcomes	CO1	Use linear algebra concepts to model, solve, and analyze real-world problems.	
	CO2	Apply probability distributions and sampling distributions to various business problems.	
	CO3	Select an appropriate graph representation for the given data.	
	CO4	Apply exploratory data analysis to some real data sets and provide interpretations via relevant visualization	
	CO5	Analyze various optimization techniques.	
	CO6	Describe Dimension Reduction Algorithms	

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Linear Algebra**	1	05
	1.1	Vectors and Matrices, Solving Linear equations, The four Fundamental Subspaces, Eigenvalues and Eigen Vectors, The Singular Value Decomposition (SVD).		
2		**Probability and Statistics**	2,3	09

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	2.1	Introduction, Random Variables and their probability Distribution, Random Sampling, Sample Characteristics and their Distributions, Chi-Square, t-, and F-Distributions: Exact Sampling Distributions, Sampling from a Bivariate Normal Distribution, The Central Limit Theorem.			
3		**Introduction to Graphs**		3,6	10
	3.1	Quantitative vs. Qualitative data, Types of Quantitative data: Continuous data, Discrete data, Types of Qualitative data: Categorical data, Binary data, Ordinary data, Plotting data using Bar graph, Pie chart, Histogram, Stem and Leaf plot, Dot plot, Scatter plot, Time-series graph, Exponential graph, Logarithmic graph, Trigonometric graph, Frequency distribution graph.			
4		**Exploratory Data Analysis**		5,6	09
	4.1	Need of exploratory data analysis, cleaning and preparing data, Feature engineering, Missing values, understand dataset through various plots and graphs, draw conclusions, deciding appropriate machine learning models.			
5		**Optimization Techniques**		4,5	10
		Types of optimization-Constrained and Unconstrained optimization, Methods of Optimization-Numerical Optimization, Bracketing Methods-Bisection Method, False Position Method, Newton's Method, Steepest Descent Method, Penalty Function Method.			
6		**Dimension Reduction Algorithms**		1,4,5	5
	6.1	Introduction to Dimension Reduction Algorithms, Linear Dimensionality Reduction: Principal component analysis, Factor Analysis, Linear discriminant analysis.			
	6.2	Non-Linear Dimensionality Reduction: Multidimensional Scaling, Isometric Feature Mapping. Minimal polynomial.			
		Total			**48**

Course Assessment:

ISE-1:

Activity: Quiz on module 1 and 2 – 10 Marks

assignment on module 3- 10 Marks

ISE-2:

Activity: Quiz on module 4 and 5- 10 Marks

Assignment on module 6- 10 Marks

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

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Text Books:

1. Gilbert Strang, "Linear Algebra for Everyone", Wellesley Cambridge Press.
2. Vijay Rohatgi, "An Introduction to Probability and Statistics, Wiley Publication.
3. An introduction to Optimization, Second Edition, Wiley-Edwin Chong, Stainslaw Zak.
4. Mathematics for Machine Learning, Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press.
5. Exploratory Data Analysis, John Tukey, Princeton University and Bell Laboratories.

References:

1. GilbertStrang, "Introduction to Linear Algebra".
2. Erwin Kreyszig, "Advanced Engineering Mathematics".
3. Mehryar Mohri, Afshin Rostamizadeh,Ameet Talwalkar, "Foundations of Machine Learning", MIT Press, 2018.
4. Shai Shalev-Shwartz,Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms",Cambridge University Press, 2014.
5. William B. Claster, "Mathematics and Programming for Machine Learning with R",CRC Press,2020.

Useful Links:

1. https://math.mit.edu/~gs/linearalgebra/
2. https://www.coursera.org/learn/probability-theory-statistics
3. https://nptel.ac.in/courses/111/105/111105090/
4. https://onlinecourses.nptel.ac.in/noc21_ma01/preview
5. https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HAIMLC601	Game Theory using AI & ML	3	--	--	3	--	--	3
		Examination Scheme						
		Theory	ISE1	MSE	ISE2	ESE	Total	
			20	30	20	100 (30% weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		--	
Course Outcomes	CO1	Understand basic concept of game theory.	
	CO2	Evaluate Artificial Intelligence (AI) methods and describe their foundations	
	CO3	Analyze and illustrate how search algorithms play vital role in problem solving, inference, perception, knowledge representation and learning.	
	CO4	Demonstrate knowledge of reasoning and knowledge representation for solving real world problems	
	CO5	Recognize the characteristics of machine learning that makes it useful to realworld problems and apply different dimensionality reduction techniques	
	CO6	Apply the different supervised learning methods of support vector machine and tree based models	

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Game Theory**	1,2	08
	1.1	Introduction, The theory of rational choice, Games with Perfect Information, Nash Equilibrium: Theory, Prisoner's Dilemma, Stag Hunt, Matching pennies, BOS, Multi NE, Cooperative and Competitive Games, Strict and Non Strict NE, Best response functions for NE.		
	1.2	Nash Equilibrium: Illustrations, Cournot's model of oligopoly, Bertrand's model of oligopoly, Electoral competition, The War of Attrition, Auctions, Mixed Strategy Equilibrium, Strategic games in which players may randomize, Dominated actions, Extensive Games with Perfect Information		
2		**Games with Imperfect Information**	1,3	08
	2.1	Bayesian Games, Introduction, Motivational examples, General definitions, two examples concerning information, Strictly Competitive Games and Max minimization, Rationalizability		
	2.2	Evolutionary Equilibrium, Monomorphic pure strategy equilibrium, Mixed strategies and polymorphic equilibrium, Repeated games: The Prisoner's Dilemma, Infinitely repeated games, Strategies, General Results.		

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3		**Introduction to AI & Problem Solving**	2,3	08
	3.1	Definitions – Foundation and History of AI, Evolution of AI - Applications of AI, Classification of AI systems with respect to environment. Artificial Intelligence vs Machine learning,		
	3.2	Heuristic Search Techniques: Generate-and-Test; Hill Climbing; Properties of A* algorithm, Best first Search; Problem Reduction.		
	3.3	Beyond Classical Search: Local search algorithms and optimization problem, local search in continuous spaces, searching with nondeterministic action and partial observation, online search agent and unknown environments.		
4		**Knowledge and Reasoning**	3,4	08
	4.1	Knowledge and Reasoning: Building a Knowledge Base: Propositional logic, first order Logic, situation calculus. Theorem Proving in First Order Logic, Planning, partial order planning. Uncertain Knowledge and Reasoning, Probabilities.		
	4.2	Bayesian Networks. Probabilistic reasoning over time: time and uncertainty, hidden Markova models, Kalman filter, dynamic bayesian network, keeping track of many objects		
5		**Introduction to ML**	3,4	08
	5.1	Introduction to Machine Learning, Examples of Machine Learning Applications, Learning Types, Supervised Learning -Learning a Class from Examples, Vapnik- Chervonenkis (VC) Dimension, probably approximately Correct (PAC) Learning, Noise, Learning Multiple Classes, Regression, Model Selection and Generalization, Dimensions of a Supervised Machine Learning Algorithm		
	5.2	Introduction, Linear Regression Models and Least Squares, Subset Selection, Shrinkage Methods, Logistic Regression- Fitting Logistic Regression Models, Quadratic Approximations and Inference, L1 Regularized Logistic Regression, SVM-Introduction to SVM, The Support Vector Classifier, Support Vector Machines and Kernels-Computing the SVM for Classification		
6		**Unsupervised Learning**	3,4	08
	6.1	Introduction, Association Rules-Market Basket Analysis, The Apriori Algorithm, Unsupervised as Supervised Learning, Generalized Association Rules, Cluster Analysis Proximity Matrices, Clustering Algorithms-K-mean, Gaussian Mixtures as Soft K-means Clustering, Example: Human Tumor Microarray Data, Vector Quantization, K-medoids, Hierarchical Clustering, Self-Organizing Maps, PCA-Spectral Clustering		
	6.2	Hidden Markov Models-Introduction, Discrete Markov Processes, Hidden Markov Models, Three Basic Problems of HMMs, Evaluation Problem, Finding the State Sequence, Learning Model Parameters, Continuous Observations, The HMM with Input, Model Selection in HMM		

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		Total		**48**

Course Assessment:

ISE-1:

Activity: Quiz on module 1 and 2 – 10 Marks

assignment on module 3- 10 Marks

ISE-2:

Activity: Quiz on module 4 and 5- 10 Marks

Assignment on module 6- 10 Marks

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Text Books:

1. Martin Osborne, "An Introduction to Game Theory", Oxford University Press.
2. Russell, S. and Norvig, "Artificial Intelligence - A Modern Approach", 3rd edition,Prentice Hall, 2015
3. Ethem Alpaydin ,"Introduction to Machine Learning", Second Edition.

References:

1. Thomas Ferguson, Stef Tijs, "Introduction to Game Theory", Hindustan Book AgencyWorld Scientific, 2018.
2. J. Gabriel, "Artificial Intelligence for Humans, Create Space Independent Publishing Platform, First edition, 2016.
3. Dan W Patterson, "Introduction to Artificial Intelligence & Expert Systems"Cengage Learning, First Edition,2011.
4. Tom Mitchell,"Machine Learning" First Edition, McGraw- Hill, 1997.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HAIMLC701	AI&ML in Healthcare	3	--	--	3	--	--	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		--	
Course Outcomes	CO1	Understand the role of AI and ML for handling Healthcare data.	
	CO2	Apply Advanced AI algorithms for Healthcare Problems	
	CO3	Learn and Apply various Computational Intelligence techniques for Healthcare Application.	
	CO4	Use evaluation metrics for evaluating healthcare systems.	
	CO5	Develop NLP applications for healthcare using various NLP Techniques.	
	CO6	Apply AI and ML algorithms for building Healthcare Applications	

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction**	1,2,4	08
	1.1	Overview of AI and ML,A Multifaceted Discipline, Applications of AI in Healthcare - Prediction, Diagnosis, personalized treatment and behavior modification, drug discovery, follow-up care etc,		
	1.2	Realizing potential of AI and ML in healthcare, Healthcare Data - Use Cases.		
2		**AI, ML, Deep Learning and Data Mining Methods for Healthcare**	1,4	08
	2.1	Knowledge discovery and Data Mining, ML, Multi classifier Decision Fusion, Ensemble Learning, Meta-Learning and other Abstract Methods.		
	2.2	Evolutionary Algorithms, Illustrative Medical Application-Multiagent Infectious Disease Propagation and Outbreak Prediction, Automated Amblyopia Screening System etc.		
	2.3	Computational Intelligence Techniques, Deep Learning, Unsupervised learning, dimensionality reduction algorithms.		
3		**Evaluating learning for Intelligence**	1,2,6	08
	3.1	Model development and workflow, evaluation metrics, Parameters and Hyperparameters, Hyperparameter tuning algorithms, multivariate testing, Ethics of Intelligence.		
4		**Natural Language Processing in Healthcare**	1,2,3	08

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	4.1	NLP tasks in Medicine, Low-level NLP components, High level NLP components, NLP Methods.		
	4.2	Clinical NLP resources and Tools, NLP Applications in Healthcare. Model Interpretability using Explainable AI for NLP applications.		
5		**Intelligent personal Health Record**	1,3,4	08
	5.1	Introduction, Guided Search for Disease Information, Recommending SCA's. Recommending HHP's , Continuous User Monitoring.		
6		**Future of Healthcare using AI and ML**	2,4	08
	6.1	Evidence based medicine, Personalized Medicine, Connected Medicine, Digital Health and Therapeutics, Conversational AI, Virtual and Augmented Reality, Blockchain for verifying supply chain, patient record access, Robot - Assisted Surgery, Smart Hospitals, Case Studies on use of AI and ML for Disease Risk Diagnosis from patient data, Augmented reality applications for Junior doctors.		
	6.2	Blockchain for verifying supply chain, patient record access, Robot - Assisted Surgery, Smart Hospitals, Case Studies on use of AI and ML for Disease Risk Diagnosis from patient data, Augmented reality applications for Junior doctors.		
		Total		**48**

Course Assessment:

ISE-1:

Activity: Quiz on module 1 and 2 – 10 Marks

assignment on module 3- 10 Marks

ISE-2:

Activity: Quiz on module 4 and 5- 10 Marks

Assignment on module 6- 10 Marks

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Textbooks:

1. Arjun Panesar, "Machine Learning and AI for Healthcare", A Press.
2. Arvin Agah, "Medical applications of Artificial Systems ", CRC Press.

References:

1. Erik R. Ranschaert Sergey MorozovPaul R. Algra, "Artificial Intelligence in medical ImagingOpportunities, Applications and Risks", Springer.
2. Sergio Consoli Diego Reforgiato Recupero Milan Petkovic,"Data Science for Healthcare Methodologies and Applications", Springer.

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3. Dac-NhuongLe, Chung Van Le, Jolanda G. Tromp, Gia Nhu Nguyen, "Emerging technologies for health and medicine", Wiley.
4. Ton J. Cleophas, Aeilko H. Zwinderman, "Machine Learning in Medicine- Complete Overview", Springer.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
HAIMLSBL701	AI&ML in Healthcare: Lab	Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		--
Course Outcomes	CO1	Students will be able to understand computational models of AI and ML.
	CO2	Students will be able to develop healthcare applications using appropriate computational tools.
	CO3	Students will be able to apply appropriate models to solve specific healthcare problems
	CO4	Students will be able to analyze and justify the performance of specific models as applied to healthcare problems.
	CO5	Students will be able to design and implement AI and ML-based healthcare applications.
	CO6	Students will be able to understand computational models of AI and ML.

Expt. No.	Name of the Experiment	Ref
1	Collect, Clean, Integrate and Transform Healthcare Data based on specific disease	1,2,3
2	Perform Exploratory data analysis of Healthcare Data.	1,2,4
3	AI for medical diagnosis based on MRI/X-ray data.	1,4,5
4	AI for medical prognosis.	1,3,4
5	Natural language Entity Extraction from medical reports.	2,4,5
6	Predict disease risk from Patient data.	3,5
7	Medical Reviews Analysis from social media data.	1,5
8	Explainable AI in healthcare for model interpretation.	1,3,5

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9	Mini Project-Design and implement innovative web/mobile based AI application using Healthcare Data.	3,4,5

Course Assessment:

ISE-1: Based on conduction of four experiments. Continuous pre-defined rubrics-based evaluation for 20 Marks.

ISE-2:   a. Four experiments. Continuous pre-defined rubrics-based evaluation for 20 Marks.

            b. Activity: Mini- Project (10 Marks)

Useful Links:

1. http://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=MachineLearning
2. http://www.cse.wustl.edu/~kilian/cse517a2010/
3. https://datarade.ai/data-categories/electronic-health-record-ehr-data
4. https://www.cms.gov/Medicare/E-Health/EHealthRecords
5. https://onlinecourses.nptel.ac.in/noc20_ee40

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
HAIMLC801	Text, Web and Social Media Analytics	Theory	20	30	20	100 (30% weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		--	
Course Outcomes	CO1	Extract Information from the text and perform data pre-processing	
	CO2	Apply clustering and classification algorithms on textual data and perform prediction.	
	CO3	Apply various web mining techniques to perform mining, searching and spamming of web data.	
	CO4	Provide solutions to the emerging problems with social media using behaviour analytics and Recommendation systems.	
	CO5	Apply machine learning techniques to perform Sentiment Analysis on data from social media.	

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction**	1,2	08
	1.1	Introduction to Text Mining: Introduction, Algorithms for Text Mining, Future Directions.		

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	1.2	Information Extraction from Text: Named Entity Recognition, Relation Extraction, Unsupervised Information Extraction.		
	1.3	Text Representation: tokenization, stemming, stop words, NER, N-gram modelling.		
2		**Clustering and Classification**	1,2,3	10
	2.1	Text Clustering: Feature Selection and Transformation Methods, distance-based Clustering Algorithms, Word and Phrase based Clustering, Probabilistic document Clustering.		
	2.2	Text Classification: Feature Selection, Decision tree Classifiers, Rule-based Classifiers, Probabilistic based Classifiers, Proximity based Classifiers.		
	2.3	Text Modelling: Bayesian Networks, Hidden Markovian Models, Markov random Fields, Conditional Random Fields		
3		**Web-Mining**	1,3	08
	3.1	Introduction to Web-Mining: Inverted indices and Compression, Latent Semantic Indexing, Web Search,		
	3.2	Meta Search: Using Similarity Scores, Rank Positons		
	3.3	Web Spamming: Content Spamming, Link Spamming, hiding Techniques, and Combating Spam		
4		**Web Usage Mining**	1,2,3	08
	4.1	Data Collection and Pre-processing, Sources and types of Data, Data Modelling, Session and Visitor Analysis, Cluster Analysis and Visitor segmentation, Association and Correlation Analysis, Analysis of Sequential and Navigational Patterns, Classification and Prediction based on Web User Transactions.		
5		**Social Media Mining:**	2,3	06
	5.1	Introduction, Challenges, Types of social Network Graphs		
	5.2	Mining Social Media: Influence and Homophily, Behaviour Analytics, Recommendation in social media: Challenges, Classical recommendation Algorithms, Recommendation using Social Context, Evaluating recommendations.		
6		**Opinion Mining and Sentiment Analysis**	2,3,4	08
	6.1	The problem of opinion mining,		
	6.2	Document Sentiment Classification: Supervised, Unsupervised.		
	6.3	Opinion Lexicon Expansion: Dictionary based, Corpus based.		
	6.4	Opinion Spam Detection: Supervised Learning, Abnormal Behaviours, Group Spam Detection.		
		Total		**48**

Course Assessment:

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ISE-1:

Activity: Quiz on module 1 and 2 – 10 Marks

assignment on module 3- 10 Marks

ISE-2:

Activity: Quiz on module 4 and 5- 10 Marks

Assignment on module 6- 10 Marks

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Textbooks:

1 Daniel Jurafsky and James H. Martin, "Speech and Language Processing", 3rd edition, 2020
2 Charu. C. Aggarwal, Cheng Xiang Zhai, "Mining Text Data", Springer Science and Business Media, 2012.
3 BingLiu, "Web Data Mining-Exploring Hyperlinks, Contents, and Usage Data", Springer, Second Edition, 2011.174
4 Reza Zafarani, Mohammad Ali Abbasiand Huan Liu, "Social Media Mining- An Introduction", Cambridge University Press, 2014

Data Science

SEM-V, VI, VII & VIII										
Course Code	**Course Name**		**Contact Hours**	**Examination Marks**					**Credits**	
				ISE1	MSE	ISE2	ESE	Total	Points	Total
HDSC501	Mathematics for Data Science	TH	4	20	30	20	30	100	4	4
HDSC601	Statistical Learning for Data Science	TH	4	20	30	20	30	100	4	4
HDSC701	Data Science for Health and Social Care	TH	4	20	30	20	30	100	4	4
HDSSBL701	Data Science for Health and Social Care: Lab	PR	4	20	-	30	-	50	2	2
HDSC801	Text, Web and Social Media Analytics	TH	4	20	30	20	30	100	4	4
		Total	**TH:TU:PR 12:0:4=16**			-	-	450	-	18

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HDSC501		4	--	--	3	--	--	4

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Mathematics for Data Science	Examination Scheme				
		ISE1	MSE	ISE2	ESE	Total
	Theory	20	30	20	100 (30% weightage)	100
	Lab	--	--	--	--	--

Pre-requisite Course Codes		Applied Mathematics, Discrete Mathematics
Course Outcomes	CO1	Use linear algebra concepts to model, solve, and analyze real-world problems.
	CO2	Apply probability distributions and sampling distributions to various business problems.
	CO3	Select an appropriate graph representation for the given data analysis.
	CO4	Apply exploratory data analysis to some real data sets and provide interpretations via relevant visualization
	CO5	Analyze various optimization techniques for data analysis.
	CO6	Describe Dimension Reduction Algorithms in analytics

Module No.	Unit No.	Topics	Ref	Hours
1		**Linear Algebra**	1	05
	1.1	Vectors and Matrices, Solving Linear equations, The four Fundamental Subspaces, Eigenvalues and Eigen Vectors, The Singular Value Decomposition (SVD).		
2		**Probability and Statistics**	1,2	09
	2.1	Introduction, Random Variables and their probability Distribution, Random Sampling, Sample Characteristics and their Distributions, Chi-Square, t-, and F-Distributions: Exact Sampling Distributions, Sampling from a Bivariate Normal Distribution, The Central Limit Theorem.		
3		**Introduction to Graphs**	5,6	10
	3.1	Quantitative vs. Qualitative data, Types of Quantitative data: Continuous data, Discrete data, Types of Qualitative data: Categorical data, Binary data, Ordinary data, Plotting data using Bar graph, Pie chart, Histogram, Stem and Leaf plot, Dot plot, Scatter plot, Time-series graph, Exponential graph, Logarithmic graph, Trigonometric graph, Frequency distribution graph.		
4		**Exploratory Data Analysis**	6	09
	4.1	Need of exploratory data analysis, cleaning and preparing data, Feature engineering, Missing values, understand dataset through various plots and graphs, draw conclusions, deciding appropriate machine learning models.		
5		**Optimization Techniques**	3,6	10

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	5.1	Types of optimization-Constrained and Unconstrained optimization, Methods of Optimization-Numerical Optimization, Bracketing Methods-Bisection Method, False Position Method, Newton's Method, Steepest Descent Method, Penalty Function Method.		
6		**Dimension Reduction Algorithms**	1,4,5	5
	6.1	Introduction to Dimension Reduction Algorithms, Linear Dimensionality Reduction: Principal component analysis, Factor Analysis, Linear discriminant analysis.		
	6.2	Non-Linear Dimensionality Reduction: Multidimensional Scaling, Isometric Feature Mapping. Minimal polynomial.		
		Total		48

Course Assessment:

ISE-1:

Activity: Quiz on module 1 and 2 – 10 marks

assignment on module 3- 10 marks

ISE-2:

Activity: Quiz on module 4 and 5- 10 marks

Assignment on module 6- 10 marks

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Text Books:

6. Gilbert Strang, "Linear Algebra for Everyone",Wellesley Cambridge Press.
7. Vijay Rohatgi, "An Introduction to Probability and Statistics, Wiley Publication.
8. An introduction to Optimization, Second Edition, Wiley-Edwin Chong, Stainslaw Zak.
9. Mathematics for Machine Learning, Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press.
10. Exploratory Data Analysis, John Tukey, Princeton University and Bell Laboratories.

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References:

6. GilbertStrang, "Introduction to Linear Algebra".
7. Erwin Kreyszig, "Advanced Engineering Mathematics".
8. Mehryar Mohri, Afshin Rostamizadeh,Ameet Talwalkar, "Foundations of Machine Learning", MIT Press, 2018.
9. Shai Shalev-Shwartz,Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014.
10. William B. Claster, "Mathematics and Programming for Machine Learning with R",CRC Press,2020

Useful Links:

1. https://math.mit.edu/~gs/linearalgebra/
2. https://www.coursera.org/learn/probability-theory-statistics
3. https://nptel.ac.in/courses/111/105/111105090/
4. https://onlinecourses.nptel.ac.in/noc21_ma01/preview
5. https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures

Course Code	Course name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HDSC601	**Statistical Learning for Data Science**	4	--	--	3	--	--	4
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		
Course Outcomes	CO1	Develop various visualizations of the data in hand.
	CO2	Analyze a real-world problem and solve it with the knowledge gained from sampling and probability distributions.
	CO3	Analyze large data sets and perform data analysis to extract meaningful insights.
	CO4	Develop and test a hypothesis about the population parameters to draw meaningful conclusions.
	CO5	Fit a regression model to data and use it for prediction.

Module No.	Unit No.	Topics	Ref	Hours
1		**Introduction**	1,3	08
	1.1	Data and Statistics: Elements, Variables, and Observations, Scales of Measurement, Categorical and Quantitative Data, Cross-Sectional and Time Series Data, Descriptive Statistics, Statistical Inference, Descriptive Statistics: Tabular and Graphical Summarizing Categorical Data, Summarizing Quantitative Data, Cross Tabulations and Scatter Diagram.		
	1.2	Descriptive Statistics: Numerical Measures: Measures of Location, Measures of Variability, Measures of Distribution Shape, Relative Location, and Detecting Outliers, Box Plot, Measures of Association Between Two Variables		
2		**Probability**	3	08
	2.1	Probability: Experiments, Counting Rules, and Assigning Probabilities, Events and Their Probabilities, Complement of an Event, Addition Law Independent Events, Multiplication Law, Baye's theorem		
	2.2	Discrete Probability Distributions, Random Variables, Discrete Probability Distributions, Expected Value and Variance, Binomial Probability Distribution, Poisson Probability Distribution		
	2.3	Continuous Probability Distributions: Uniform Probability Distribution, Normal Curve, Standard Normal Probability Distribution, Computing Probabilities for Any Normal Probability Distribution		
3		**Sampling and Sampling Distributions**	1,2	05

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	3.1	Sampling from a Finite Population, Sampling from an Infinite Population, Other Sampling Methods, Stratified Random Sampling, Cluster Sampling, Systematic Sampling, Convenience Sampling, Judgment Sampling		
	3.2	Interval Estimation: Population Mean: Known, Population Mean: Unknown, Determining the Sample Size, Population Proportion		
4		**Hypothesis Tests**	1,2	05
	4.1	Developing Null and Alternative Hypotheses, Type I and Type II Errors, Population Mean: Known Population Mean: Unknown Inference About Means and Proportions with Two Populations-Inferences About Population Variances, Inferences About a Population Variance, Inferences About Two Population Variances		
	4.2	Tests of Goodness of Fit and Independence, Goodness of Fit Test: A Multinomial Population, Test of Independence		
5		**Regression**	1,3	08
	5.1	Simple Linear Regression: Simple Linear Regression Model, Regression Model and Regression Equation, Estimated Regression Equation, Least Squares Method, Coefficient of Determination, Correlation Coefficient, Model Assumptions, testing for Significance, Using the Estimated Regression Equation for Estimation and Prediction Residual Analysis: Validating Model Assumptions, Residual Analysis: Outliers and Influential Observations		
	5.2	Multiple Regression: Multiple Regression Model, Least Squares Method, Multiple Coefficient of Determination, Model Assumptions, Testing for Significance, Categorical Independent Variables, Residual Analysis		
6		**Time Series Analysis and Forecasting**	1,2,3	5
	6.1	Time Series Patterns, Forecast Accuracy, Moving Averages and Exponential Smoothing, Trend Projection, Seasonality and Trend and Time Series Decomposition		
	6.2	Nonparametric Methods, Sign Test, Wilcoxon Signed-Rank Test, Mann-Whitney-Wilcoxon Test, Kruskal Wallis Test, Rank Correlation		
		Total		**48**

Course Assessment:

    ISE-1:

    Activity: Quiz on module 1 and 2 – 10 marks

    assignment on module 3- 10 marks

    ISE-2:

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Activity: Quiz on module 4 and 5- 10 marks

Assignment on module 6- 10 marks

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Text Books:

1. O'Reilly, Joel Grus, "Data Science from Scratch",FIRST PRINCIPLES WITH PYTHON.
2. O'Reilly, Aileen Nielse, "Practical Time Series Analysis, Prediction with statistics and Machine Learning.
3. O'Reilly, Garrett Grolemund, Hadley Wickham, "R for data science: Import, Tidy, Transform, Visualize, And Model Data.
4. O'Reilly Media, Wes McKinney, "Python for Data Analysis", 2nd Edition, O'Reilly Media, Wes McKinney.

References:

1. Lillian Pierson, "Data Science for Dummies Paperback", Wiley Publications.
2. Cole Nussbaumer Knaflic, "Storytelling with Data: A Data Visualization, Guide for Business Professionals", Wiley Publication,
3. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences", Cengage Publication.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HDSC701	Data Science for Health and Social Care	4	--	--	3	--	--	4
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		
Course Outcomes	CO1	Identify sources and structure of healthcare data.
	CO2	Apply structured lifecycle approach for handling Healthcare data science projects.
	CO3	Analyze the data, create models, and identify insights from Healthcare data.
	CO4	Apply various data analysis and visualization techniques for Healthcare and social media data.
	CO5	Apply various algorithms and develop models for Healthcare data science projects.
	CO6	To Provide data science solutions for solving problems of Health and Social Care.

Module No.	Unit No.	Topics	Ref	Hours
1		**Data Science for Healthcare**	1,5,6	08
	1.1	Introduction, Healthcare Data Sources and Data Analytics for Healthcare, Applications and Practical Systems for Healthcare.		
	1.2	Electronic Health Records (EHR), Components of EHR, Benefits of EHR, Barriers to Adopting EHR, Challenges of using EHR data, Phenotyping Algorithms		
2		**Biomedical Image Analysis**	1,2,3	08
	2.1	Biomedical Imaging Modalities, Object detection, Image segmentation, Image Registration, Feature Extraction		
	2.2	Mining of Sensor data in Healthcare, Challenges in Healthcare Data Analysis		
	2.3	Biomedical Signal Analysis, Genomic Data Analysis for Personalized Medicine.		
3		**Data Science and Natural Language Processing for Clinical Text**	1,2,3	08
	3.1	NLP, Mining information from Clinical Text, Information Extraction, Rule Based Approaches, Pattern based algorithms, Machine Learning Algorithms.		

	3.2	Clinical Text Corpora and evaluation metrics, challenges in processing clinical reports, Clinical Applications.		
4		**Social Media Analytics for Healthcare**	2,6	08
	4.1	Social Media analysis for detection and tracking of Infectious Disease outbreaks.		
	4.2	Outbreak detection, Social Media Analysis for Public Health Research, Analysis of Social Media Use in Healthcare		
5		**Advanced Data Analytics for Healthcare**	2,5,6	08
	5.1	Review of Clinical Prediction Models, Temporal Data Mining for Healthcare Data		
	5.2	Visual Analytics for Healthcare Data, Information Retrieval for Healthcare- Data Publishing Methods in Healthcare.		
6		**Data Science Practical Systems for Healthcare**	1,2,6	08
	6.1	Data Analytics for Pervasive Health, Fraud Detection in Healthcare		
	6.2	Data Analytics for Pharmaceutical discoveries, Clinical Decision Support Systems		
	6.3	Computer-Assisted Medical Image Analysis Systems- Mobile Imaging and Analytics for Biomedical Data.		
		Total		**48**

Course Assessment:

ISE-1: Activity: Quiz on module 1 and 2 – 10 marks

assignment on module 3- 10 marks

ISE-2: Activity: Quiz on module 4 and 5- 10 marks

Assignment on module 6- 10 marks

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE : Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Textbooks:

1. Chandan K. Reddy and Charu C Aggarwal, "Healthcare data analytics", Taylor & Francis, 2015.
2. Hui Yang and Eva K. Lee, "Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016.

References:

1. Madsen, L. B. (2015). Data-driven healthcare: how analytics and BI are transforming the industry. Wiley India Private Limited
2. Strome, T. L., & Liefer, A. (2013). Healthcare analytics for quality and performance improvement. Hoboken, NJ, USA: Wiley
3. McNeill, D., & Davenport, "Analytics in Healthcare and the Life Sciences: Strategies, Implementation Methods, and Best Practices. Pearson Education,2013.

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4. Rachel Schutt and Cathy O'Neil, "Doing Data Science", O'Reilly Media
5. Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly Media
6. EMC Education Services, "Data Science and Big Data Analytics",Wiley.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HDSSBL701	Data Science for Health and Social Care: Lab	--	--	4	--	--	2	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		

Course Outcomes	CO1	Identify sources of data, and suggest methods for collecting, sharing and analysing Healthcare data.
	CO2	Clean, integrate and transform healthcare data.
	CO3	Apply various data analysis and visualization techniques
	CO4	Apply various algorithms and develop models for healthcare data Analytics.
	CO5	Implement data science solutions for solving healthcare problems.

Expt. No.	Title
1	Clean, Integrate and Transform Electronic Healthcare Records.
2	Apply various data analysis and visualization techniques on EHR.
3	Bio Medical Image Preprocessing, Segmentation.
4	Bio Medical Image Analytics.
5	Text Analytics for Clinical Text Data.
6	Diagnose disease risk from Patient data.
7	Social Media Analytics for outbreak prediction/ Drug review analytics
8	Visual Analytics for Healthcare Data
9	Implement an innovative Data Science application based on Healthcare Data.
10	Documentation and Presentation of Mini Project.

Course Assessment:

ISE1: Continuous pre-defined rubrics-based evaluation for 20 marks.

ISE-2: a. Four experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

b. Activity: Mini- Project (10 marks)

Useful Links:

1. http://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=MachineLearning

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2. http://www.cse.wustl.edu/~kilian/cse517a2010/
3. https://datarade.ai/data-categories/electronic-health-record-ehr-data
4. https://www.cms.gov/Medicare/E-Health/EHealthRecords
5. https://onlinecourses.nptel.ac.in/noc20_ee40

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HDSC801	Text, Web and Social Media Analytics	3	--	--	3	--	--	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100 (30% weightage)		100
		Lab	--	--	--	--		--

Pre-requisite Course Codes			
Course Outcomes	CO1	Extract Information from the text and perform data pre-processing	
	CO2	Apply clustering and classification algorithms on textual data and perform prediction.	
	CO3	Apply various web mining techniques to perform mining, searching and spamming of web data.	
	CO4	Provide solutions to the emerging problems with social media using behavior analytics and Recommendation systems.	
	CO5	Apply machine learning techniques to perform Sentiment Analysis on data from social media	

Module No.	Unit No.	Topics	Ref	Hours
1		**Introduction**	1,2	08
	1.1	Introduction, Healthcare Data Sources and Data Analytics for Healthcare, Applications and Practical Systems for Healthcare.		
	1.2	Information Extraction from Text: Named Entity Recognition, Relation Extraction, Unsupervised Information Extraction		
	1.3	Text Representation: tokenization, stemming, stop words, NER, N-gram modelling		
2		**Clustering and Classification**	1,2.3	10
	2.1	Text Clustering: Feature Selection and Transformation Methods, distance based Clustering Algorithms, Word and Phrase based Clustering, Probabilistic document Clustering		
	2.2	Text Classification: Feature Selection, Decision tree Classifiers, Rule-based Classifiers, Probabilistic based Classifiers, Proximity based Classifiers.		
	2.3	Text Modelling: Bayesian Networks, Hidden Markovian Models, Markov random Fields, Conditional Random Fields		
3		**Web-Mining**	2,3	08
	3.1	Introduction to Web-Mining: Inverted indices and Compression, Latent Semantic Indexing, Web Search		

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	3.2	Meta Search: Using Similarity Scores, Rank Positons		
	3.3	Web Spamming: Content Spamming, Link Spamming, hiding Techniques, and Combating Spam		
4		**Web Usage Mining**	2,3,4	05
	4.1	Data Collection and Pre-processing, Sources and types of Data, Data Modelling, Session and Visitor Analysis, Cluster Analysis and Visitor segmentation, Association and Correlation Analysis, Analysis of Sequential and Navigational Patterns, Classification and Prediction based on Web User Transactions.		
5		**Social Media Mining:**	2,3	05
	5.1	Introduction, Challenges, Types of social Network Graphs		
	5.2	Mining Social Media: Influence and Homophily, Behaviour Analytics, Recommendation in Social Media: Challenges, Classical recommendation Algorithms, Recommendation using Social Context, Evaluating recommendations.		
6		**Opinion Mining and Sentiment Analysis**	1,2,3	08
	6.1	The problem of opinion mining,		
	6.2	Document Sentiment Classification: Supervised, Unsupervised.		
	6.3	Opinion Lexicon Expansion: Dictionary based, Corpus based.		
	6.4	Opinion Spam Detection: Supervised Learning, Abnormal Behaviors, Group Spam Detection.		
		Total		**48**

Course Assessment:

ISE-1:

Activity: Quiz on module 1 and 2 – 10 marks

assignment on module 3- 10 marks

ISE-2:

Activity: Quiz on module 4 and 5- 10 marks

Assignment on module 6- 10 marks

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Textbooks:

1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing," 3rd edition, 2020
2. Charu. C. Aggarwal, Cheng Xiang Zhai, Mining Text Data, Springer Science and Business Media, 2012.
3. BingLiu, "Web Data Mining-Exploring Hyperlinks, Contents, and Usage Data", Springer, Second Edition, 2011.

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4. Reza Zafarani, Mohammad Ali Abbasiand Huan Liu, "Social Media Mining- An Introduction", Cambridge University Press

BLOCKCHAIN

SEM-V, VI, VII & VIII										
Course Code	**Course Name**		**Contact Hours**	**Examination Marks**					**Credits**	
				ISE1	MSE	ISE2	ESE	Total	Points	Total
HBCC501	Bitcoin and Cryptocurrency	TH	4	20	30	20	30	100	4	4
HBCC601	Blockchain Platform	TH	4	20	30	20	30	100	4	4
HBCC701	Block chain Development	TH	4	20	30	20	30	100	4	4
HBCSBL701	Private Blockchain Setup Lab (SBL)	PR	4	20	-	30	-	50	2	2
HBCC801	DeFi (Decentralized Finance)	TH	4	20	30	20	30	100	4	4
	Total		TH:TU:PR 12:0:4=16			-	-	450	-	18

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HBCC 501	**Bitcoin and Crypto currency**	4	--	--	4	--	--	4
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes	CSC602	
Course Outcomes	CO1	Describe the basic concept of Block chain
	CO2	Associate knowledge of consensus and mining in Block chain
	CO3	Summarize the bit coin crypto currency at an abstract level
	CO4	Apply the concepts of keys, wallets and transactions in the Bit coin network

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| | CO5 | Interpret the knowledge of Bit coin network, nodes and their roles |
| | CO6 | Illustrate the applications of Block chain and analyze case studies |

Sr. No.	Module	Detailed Content	Ref.	Hours
0	Prerequisite	**Introduction to Cryptography:** Hash functions, Public key cryptography, Digital Signature (ECDSA).		**2**
1	**Introduction to Block chain**	Structure of a Block, Block Header, Block Identifiers: Block Header Hash and Block Height, The Genesis Block, Linking Blocks in the Block chain, Merkle Trees and Simplified Payment Verification (SPV). **Self-learning Topics:** Block chain Demo.	**1,3**	**6**
2	**Consensus and Mining**	Decentralized Consensus, Byzantine General's Problem, Independent Verification of Transactions, Mining Nodes, Aggregating Transactions into Blocks, Constructing the Block header, Mining the Block, Successfully Mining the Block, Validating a New Block, Assembling and Selecting Chains of Blocks, Block chain Forks **Self-learning Topics:** Study different consensus algorithms	**2,3**	**12**
3	**Introduction to Bit coin**	What is Bit coin and the history of Bit coin, Getting the first bit coin, finding the current price of bit coin and sending and receiving bit coin, Bit coin Transactions. **Self-learning Topics:** Study the Website coinmarketcap.com/	**1,3**	**4**
4	**Concepts of Bit coin**	**Keys and addresses, Wallets and Transactions:** Public Key Cryptography and Crypto currency, Private and Public Keys, Bit coin Addresses, Base58 and Base58Check Encoding, Nondeterministic (Random) Wallets, Deterministic (Seeded) Wallets, HD Wallets (BIP-32/BIP-44), Wallet Best Practices, Using a Bit coin Wallets, Transaction Outputs and Inputs, Transaction Fees, Transaction Scripts and Script Language, Turing Incompleteness, Stateless Verification, Script Construction (Lock + Unlock), Pay-to-Public-Key-Hash (P2PKH), Bitcoin Addresses, Balances, and Other Abstractions	**1,3**	**13**

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		Self-learning Topics: Visit and use https://bitcoin.org/en/		
5	**Bit coin Networks**	Peer-to-Peer Network Architecture, Node Types and Roles, Incentive based Engineering The Extended Bitcoin Network, Bitcoin Relay Networks, Network Discovery, Full Nodes, Exchanging "Inventory", Simplified Payment Verification (SPV) Nodes, Bloom Filters, SPV Nodes and Privacy, Encrypted and Authenticated Connections, Transaction Pools **Self-learning Topics:** Study technical papers based on bitcoin security	**1,4, 6**	**7**
6	**Blockchain Applications & case studies**	Domain-Specific Applications: FinTech, Internet of Things, Industrial and Manufacturing, Energy, Supply chain & Logistics, Records & Identities, Healthcare Case studies related to cryptocurrencies Concept of Altcoin **Self-learning Topics:** Read Technical papers on blockchain applications	**2,6**	**8**

Recommended Books:

1. "Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN", 2nd Edition by Andreas M. Antonopoulos, June 2017, O'Reilly Media, Inc. ISBN: 9781491954386.
2. "Blockchain Applications: A Hands-On Approach", by Arshdeep Bahga, Vijay Madisetti, Paperback – 31 January 2017.
3. "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", July 19, 2016, by Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, Princeton University Press.
4. Mastering Blockchain", by Imran Bashir, Third Edition, Packt Publishing
5. **"**Mastering Ethereum: Building Smart Contracts and Dapps Paperback" by Andreas Antonopoulos, Gavin Wood, Publisher(s): O'Reilly Media
6. "Blockchain Revolution: How the Technology Behind Bitcoin is Changing Money, Business and the World", Don Tapscott and Alex Tapscot, Portfolio Penguin, 856157449

Online References:

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Sr. No.	Website Name
1	https://andersbrownworth.com/blockchain/
2	https://andersbrownworth.com/blockchain/public-private-keys/
3	https://www.coursera.org/learn/cryptocurrency
4	https://coinmarketcap.com/

Course Assessment:

Theory:

ISE-1:

Activity: Quiz and assignments 20 Marks

ISE-2: Two hours 20 Marks

Activity: Article Discussion, Quiz and Assignments

Outcome: Reflective Journal

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		4	--	--	4	--	--	4
		Examination Scheme						
HBCC 601	**Blockchain Platform**		ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	
		Lab	--	--	--	--	--	

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Pre-requisite Course Codes	HBCC 501	
Course Outcomes	CO1	Understand the blockchain platform and its terminologies
	CO2	Understand smart contracts, wallets, and consensus protocols
	CO3	Design and develop decentralized applications using Ethereum, and Hyperledger
	CO4	Creating blockchain networks using Hyperledger Fabric deployment
	CO5	Understand the considerations for creating blockchain applications
	CO6	Analyze various Blockchain Platforms

Sr. No.	Module	Detailed Content	Ref.	Hours
0	**Prerequisite**	Introduction to Block chain and Bitcoin	1,2	2
1	**Introduction to Block chain Platforms**	Why Blockchain Platform: Platform types, Public, Private, technology requirements for implementation. Introduction to Ethereum, Hyperledger and Smart Contracts. Case study of blockchain Application. **Self-learning Topics:** Study different applications of block chain.	1,2	6
2	**Public Block chain**	Introduction, Characteristics of Public Blockchain, Advantages. Examples of Public Blockchain-Bitcoin: Terminologies and Transaction, Ethereum: Smart contract, Comparison of Bitcoin and Ethereum, Other public Blockchain platforms. **Self-learning Topics:** Study any one case study on public block chain.	1,2,3	8

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3	**Ethereum Blockchain**	Introduction, Ethereum and Its Components: Mining, Gas, Ethereum, Ether, Ethereum Virtual Machine, Transaction, Accounts. Architecture of ethereum, Smart Contract: Remix IDE, Developing smart contract for ethereum blockchain, e-voting applications using smart contract, Dapp Architecture. Types of test-networks used in ethereum, Transferring Ethers Using MetaMask, Mist Wallet, Ethereum Frameworks, Case study of Ganache for ethereum blockchain. Deploying e-voting applications on Ganache framework. Ethereum 2., Concept of Beacon chain, POS (Proof of Stake), Shading of Chain. **Self-learning Topics:** Study case study on any ethereum blockchain.	1,2,3	12
4	**Private Blockchain**	Introduction, Key Characteristics, Need of Private Blockchain. Consensus Algorithm for private Blockchain (Ex. RAFT and PAXOS), Smart Contract in Private Blockchain, Case Study of E-commerce Website, Design Limitations. **Self-learning Topics:** Case study on private block chain.	1,2,3	8
5	**Hyperledger Blockchain**	Introduction to Hyperledger, tools and frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric & Other Technologies, Distributed Ledgers. Hyperledger Fabric Architecture, Components of Hyperledger Fabric: MSP, Chain Codes etc., Transaction Flow, Advantages of Hyperledger Fabric Blockchain, working of Hyperledger Fabric, Creating Hyperlegder network, Case Study of Supply chain management using Hyperledger **Self-learning Topics:** Case study on Hyperledger blockchain.	1.5	12
6	**Other Blockchain platforms**	Corda, Ripple, Quorum and other emerging blockchain platforms, Case Study on any of the blockchain platforms. Developing Blockchain application on Cloud (AWS/Azure) **Self-learning Topics:** Compare different blockchain platforms.	1,7	4

Recommended Books:

1. Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhillash K. A

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and Meena Karthikeyen, Universities press.

2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly

3. Blockchain for Beginners, Yathish R and Tejaswini N, SPD

4. Blockchain Basics, A non-Technical Introduction in 25 Steps, Daniel Drescher, Apress.

5. Blockchain with Hyperledger Fabric, Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing

6. Blockchain By Example, Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, November 2018, Implement decentralized blockchain applications to build scalable Dapps.

7. Blockchain for Business, https://www.ibm.com/downloads/cas/3EGWKGX7.

Online References:

Sr. No.	Website Name
1.	https://www.hyperledger.org/use/fabric

Course Assessment:

ISE-1: Activity: Quiz and assignments 20 Marks

ISE-2: Two hours 20 Marks

Activity: Article Discussion, Quiz and Assignments Outcome: Reflective Journal

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HBCC701	Blockchain Development	4	--	--	4	--	--	4
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisites		HBCC501, HBCC601
Course Outcomes	CO1	To use Ethereum Components.
	CO2	To analyze different blockchain programming languages.
	CO3	To implement smart contract in Ethereum using solidity.
	CO4	To analyze different development frameworks.
	CO5	To implement private blockchain network with Hyperledger fabric.
	CO6	To illustrate blockchain integration with emerging technologies and security issues.

Module No.	Unit No.	Topics	Ref.	Hours.
1	1.1	Ethereum components: miner and mining node, Ethereum virtual machine, Ether, Gas, Transactions, accounts, swarm and whisper, Ethash, end to end transaction in Ethereum, architecture of Ethereum	1,2	4
2	2.1	Types of Blockchain Programming, Solidity, GoLang, Vyper, Java, Simplicity, Rholang, Game Theory and	1,2	8

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		Cryptonomics, Comparative study of different blockchain programming languages		
	2.2	Decentralized file system-IPFS		
3	3.1	Solidity programming, Smart Contract programming using solidity, mapper function, ERC20 and ERC721 Tokens, comparison between ERC20 & ERC721, ICO, STO Metamask (Ethereum Wallet), setting up development environment, use cases of smart contract, smart Contracts: Opportunities, Risks	1,2	10
4	4.1	Ethereum client, Ethereum Network, Introduction to Go Ethereum (Geth), Geth Installation and Geth CLI, Setting up a Private Ethereum Blockchain. Introduction to Truffle, Smart Contract deployment on a Private Blockchain.	1,2	10
	4.2	Introduction to Ganache, Introduction to Dapp, Dapp architecture, Dapps Scalability, testing Introduction to Dapp, Dapp architecture, Dapps Scalability, testing.		
	4.3	Connecting to the Blockchain and Smart Contract, Web3js, Deployment		
5	5.1	Installing Hyperledger Fabric, Hyperledger Fabric Network, Building Your First Network, Hyperledger Fabric Demo, Hyperledger Fabric Network Configuration, Certificate Authorities, Chaincode Development and Invocation, Deployment and testing of chaincode on development network, Hyperledger Fabric Transactions.	1,2	12
6	6.1	Integrating Blockchain with cloud, IoT, AI, ERP, End to end blockchain integration, Risks and Limitations of Blockchain: Privacy & Security. Criminal Use of Payment Blockchains, The "Dark" Side of Blockchain	1,2	6
	6.2	Research challenges in blockchain		

Recommended Books:

1. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
2. Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhillash K. A and Meena Karthikeyen, Universities press

Course Assessment:

Theory:

ISE-1:

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Activity: Quiz and assignments 20 Marks

ISE-2: Two hours 20 Marks

Activity: Article Discussion, Quiz and Assignments

Outcome: Reflective Journal

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	4	--	--	2	2
HBCSBL701	**Private Blockchain Setup Lab (SBL)**	**Examination Scheme**						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Expertise in Programming, Basic knowledge of Computer Security, Networking.
Course Outcomes	1	To build and test Private Ethereum Blockchain.
	2	To learn the concept of the genesis block and Account in the Blockchain.
	3	To get familiar with the mining blocks to create a ether.
	4	To understand and apply the concepts of keys, wallets.
	5	To acquire the knowledge of gateway and desktop application.
	6	To analyze the applications & case studies of Blockchain.

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Module No.	Module	Topics	CO Mapping	Hrs.
1	Build and Test	Install Ethereum network to create a private Ethereum Blockchain	CO1	4
2	Build and Test	Installation of Geth	CO1	5
3	Create the Genesis block	Create the genesis block using Puppeth, a CLI tool	CO2	5
4	Create Account in the blockchain	Smart contract	CO2	6
5	Mining Blocks to create Ether	Mine blocks, check account balance, PoW vs PoS	CO3	6
6	Gateway to Blockchain Apps	Metamask	CO4	5
7	Web and Desktop Application	Solidity programming on remix	CO4	6
8	Application Development	Crypto Exchange and Wallet	CO5	4
9	Application Development	Blockchain Mobile App or Web Application using Dapp	CO6	6
10	Application Development	Hosting of a private blockchain on cloud (AWS/Azure)	CO6	5
			Total	52

Course Assessment:

Lab:

ISE:

1. **ISE-1** Quizzes/Assignments/Paper Presentation/Article Discussion
   Quizzes/Assignments based on 50% experiments
2. **ISE-2** Quizzes/Assignments/Paper Presentation/Article Discussion
   Quizzes/Assignments based on 50% experiments

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Recommended Books:

1. Mastering Ethereum: Building Smart Contracts and Dapps, Andreas Antonopoulos, Gavin Wood, O'Reilly Publication.
2. Mastering Blockchain, Second Edition: Distributed Ledger technology, decentralization, and smart contracts explained,2nd Edition, Imran Bashir.
3. Solidity Programming Essentials: A beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Ritesh Modi, Packt publication.
4. Mastering Blockchain, Imran Bashir, Second Edition, Packt Publication.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		4	--	--	4	--	--	4
HBCC801	DeFi (Decentralized Finance)	Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisites	HBCC501, HBCC601, HBCC701	
	CO1	Explain the basic concepts of Centralized and Decentralized Finance and compare them.
Course Outcomes	CO2	Describe the DeFi System and its key categories.
	CO3	Discuss the DeFi components, primitives, incentives, metrics and major business models where they are used.

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	CO4	Explain the DeFi Architecture and EcoSystem.
	CO5	Illustrate the DeFi protocols.
	CO6	Discuss the real time use cases of DeFi.

Module No.		Topics	Ref.	Hours.
1	1.1	Difference between Centralized and Decentralized Finance	1,2,3	06
	1.2	**Traditional Financial Institution- Banks:** 1. Payment and Clearance systems, 2. Accessibility, 3. Centralization and transparency		
	1.3	Decentralized Finance Vs Traditional Finance		
2	2.1	The DeFi Ecosystem, Problems that DeFi Solves How Decentralized is DeFi?	1,2,3	06
	2.2	**Defi key Categories:** Stablecoins, Stable coin and pegging, Lending and Borrowing, Exchanges, Derivations, Fund Management, Lottery, Payments, Insurance		
3	3.1	**DeFi Components:** Blockchain Cryptocurrency The Smart Contract Platform Oracles Stablecoins Decentralized Applications	1,2,3	10
	3.2	**DeFi Primitives:** Transactions Fungible Token: Equity Tokens, Utility Tokens and Governance Tokens NFT: NFT Standard, **Multi-token standard Custody Supply Adjustment:** Burn-Reduce Supply, Mint-Increase Supply, Bonding Curve- Pricing Supply **Incentives**: Staking Rewards, Slashing, Direct Rewards and Keepers, Fees **Swap**: Order Book Matching, Automated Market Makers Collaterlized Loans Flash Loans (Uncollaterlized Loans)		
	3.3	**DeFi Key Metrics:** Total Value Locked, Daily Active Users, Market Cap		
	3.4	**DeFi Major Business Models**: Decentralized Currencies, Decentralized Payment Services, Decentralized fundraising,		

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		Decentralized Contracting		
4	4.1	**DeFi Architecture:** Consumer Layer: Blockchains, Cross-Blockchain networks, Oracles **Digital Asset Layer:** Cryptocurrencies, Infrastructure Layer: Wallets and Asset Management, DEXes and Liquidity, Lending and Borrowing, Prediction Markets, Synthetic Assets, Insurance	1,2,3	10
	4.2	**DeFi EcoSystem and Protocols:** On-chain Asset Exchange, Loanable Fund Markets on-chain assets, Stablecoins, Portfolio Management, Derivatives, Privacy-preserving mixers		
	4.3	**DeFi Risk and Challenges:** Technical Risks, Usability Risks, Centralization Risks, Liquidity Risks, Regulation Risk		
5	5.1	**Maker DAO**: Maker Protocol: Dai Stablecoins, Maker Vaults, Maker Protocol Auctions **Maker Actors:** Keepers, Price Oracles, Emergency Oracles, DAO Teams, Dai Savings Rate, Dai Use case Benefits and Examples	1,2,3	10
	5.2	**UniSwap:** UniSwap Protocol Overview: How UniSwap Works, EcoSystem Participants, Smart Contracts **UniSwap Core Concepts**: Swaps, Pools, Flash Swaps, Oracles		
	5.3	**Compound: Compound Protocol:** Supplying Assets, Borrowing Assets, Interest Rate Model Compound **Implementation and Architecture:** cToken, Contracts, Interest Rate Mechanics, Borrowing, Liquidation, Price Feeds, Comptroller, Governance		
	5.4	**wBTC**: Need for wBTC: Tokenization and common Issues **wBTC Implementation and Technology:** Users, Custodian Wallet Setup, Minting, Burning wBTC Governance, wBTC vs Atomic Swaps, Fees, Legal Binding, Trust Model and Transparency		
6	6.1	Decentralized Exchanges	1,2,3	08
	6.2	Decentralized Stablecoins		
	6.3	Decentralized Money Markets		
	6.4	Decentralized Synthetix		

	6.5	Decentralized Insurance		
	6.6	Decentralized Autonomous Organization (DAO)		

Recommended Books:

1. How to DeFi,Darren Lau, Daryl Lau, Teh Sze Jin,Kristian Kho, Erina Azmi, TM Lee,Bobby Ong- 1st Edition, March 2020
2. DeFi and the Future of Finance-Campbell R. Harvey
3. DeFi Adoption 2020 A Definitive Guide to Entering the Industry

Course Assessment:

Theory:

ISE-1:

Activity: Quiz and assignments 20 Marks

ISE-2: Two hours 20 Marks

Activity: Article Discussion, Quiz and Assignments

Outcome: Reflective Journal

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

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CYBER SECURITY

SEM-V, VI, VII & VIII										
Course Code	Course Name		Contact Hours	Examination Marks					Credits	
				ISE1	MSE	ISE2	ESE	Total	Points	Total
HCSC501	Ethical Hacking	TH	4	20	30	20	30	100	4	4
HCSC601	Digital Forensic	TH	4	20	30	20	30	100	4	4
HCSC701	Security Information Management	TH	4	20	30	20	30	100	4	4
HCSSBL701	Vulnerability Assessment Penetration Testing (VAPT) Lab (SBL)	PR	4	20	-	30	-	50	2	2
HCSC801	Application Security	TH	4	20	30	20	30	100	4	4
	Total		TH:TU:PR 12:0:4=16			-	-	450	-	18

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		4	--	--	4	--	--	4
HCSC 501	Ethical Hacking	Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100 (30% weightage)		100
		Lab	--	--	--	--		--

Pre-requisite Course Codes		
Course Outcomes	CO1	Articulate the fundamentals of Computer Networks, IP Routing and core concepts of ethical hacking in real world scenarios.
	CO2	Apply the knowledge of information gathering to perform penetration testing and social engineering attacks.
	CO3	Demonstrate the core concepts of Cryptography, Cryptographic checksums and evaluate the various biometric authentication mechanisms
	CO4	Apply the knowledge of network reconnaissance to perform Network and web application-based attacks
	CO5	Apply the concepts of hardware elements and endpoint security to provide security to physical devices
	CO6	Simulate various attack scenarios and evaluate the results

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Sr. No.	Module	Detailed Content	Ref.	Hours
0	**Prerequisite**	Computer Networks, Databases, system security		**2**
1	**Introduction to Ethical Hacking**	Fundamentals of Computer Networks/IP protocol stack, IP addressing and routing, Routing protocol, Protocol vulnerabilities, Steps of ethical hacking, Demonstration of Routing Protocols using Cisco Packet Tracer **Self-learning Topics**: TCP/IP model, OSI model	**1, 2**	**10**
2	**Introduction to Cryptography**	Private-key encryption, public key-encryption, key Exchange Protocols, Cryptographic Hash Functions & applications, steganography, biometric authentication, lightweight cryptographic algorithms. Demonstration of various cryptographic tools and hashing algorithms **Self-learning Topics**: Quantum cryptography, Elliptic curve cryptography	**1, 7**	**08**
3	**Introduction to network security**	Information gathering, reconnaissance, scanning, vulnerability assessment, Open VAS, Nessus, System hacking: Password cracking, penetration testing, Social engineering attacks, Malware threats, hacking wireless networks (WEP, WPA, WPA- 2), Proxy network, VPN security, Study of various tools for Network Security such as Wireshark, John the Ripper, Metasploit, etc. **Self-learning Topics**: Ransomware (Wannacry), Botnets, Rootkits, Mobile device security	**3, 4**	**12**
4	**Introduction to web security and Attacks**	OWASP, Web Security Considerations, User Authentication, Cookies, SSL, HTTPS, Privacy on Web, Account Harvesting, Web Bugs, Sniffing, ARP poisoning, Denial of service attacks, Hacking Web Applications, Clickjacking, Cross-Site scripting and Request Forgery, Session Hijacking and Management, Phishing and Pharming Techniques, SSO, Vulnerability assessments, SQL injection, Web Service Security, OAuth 2.0, Demonstration of hacking tools on Kali Linux such as SQLMap, HTTrack, hping, burp suite, Wireshark etc. **Self-learning Topics**: Format string attacks	**1, 5**	**10**

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5	**Elements of Hardware Security**	Side channel attacks, physical unclonable functions, Firewalls, Backdoors and trapdoors, Demonstration of Side Channel Attacks on RSA, IDS and Honeypots. **Self-learning Topics**: IoT security	4, 5	6
6	**Case Studies**	Various attacks scenarios and their remedies. Demonstration of attacks using DVWA. **Self-learning Topics**: Session hijacking and man-in-middle attacks	5, 6	4

Recommended Books:

1. Computer Security Principles and Practice --William Stallings, Seventh Edition, Pearson Education, 2017
2. Security in Computing -- Charles P. Pfleeger, Fifth Edition, Pearson Education, 2015
3. Network Security and Cryptography -- Bernard Menezes, Cengage Learning, 2014
4. Network Security Bible -- Eric Cole, Second Edition, Wiley, 2011
5. Mark Stamp's Information Security: Principles and Practice --Deven Shah, Wiley, 2009
6. UNIX Network Programming –Richard Steven, Addison Wesley, 2003
7. Applied Cryptography, Protocols Algorithms and Source code in C -- Bruce Schneier, 2nd Edition / 20th Anniversary Edition, Wiley, 2015

Online Resources:

Sr. No.	Website Name
1.	https://www.owasp.org/index.php/Category:OWASP_Top_Ten_Project
2.	https://dvwa.co.uk/
3.	http://testphp.vulnweb.com/

Course Assessment:

Theory:

ISE-1:

Activity: Quiz and assignments 20 Marks

ISE-2: Two hours 20 Marks

Activity: Article Discussion, Quiz and Assignments

Outcome: Reflective Journal

MSE: Two hours 30 Marks written examination based on 50% syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		4	--	--	4	--	--	4
HCSC 601	Digital forensic	**Examination Scheme**						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		
Course Outcomes	CO1	Identify and define the class for various computer and cyber-crimes in the digital world
	CO2	Understand the need of digital forensic and the role of digital evidence
	CO3	Understand and analyze the role of File systems in computer forensics
	CO4	Demonstrate the incident response methodology with the best practices for incidence response with the application of forensics tools.
	CO5	Generate/Write the report on application of appropriate computer forensic tools for investigation of any computer security incident.
	CO6	Identify and investigate threats in network and mobile.

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Sr. No.	Module	Detailed Content	Ref.	Hours
	Prerequisite	**Computer Hardware**: Motherboard, CPU, Memory: RAM, Hard Disk Drive (HDD), Solid State Drive (SSD), Optical drive **Computer Networks:** Introduction CN Terminology: Router, Gateway, OSI and TCP/IP Layers **Operating Systems:** Role of OS in file management, Memory management utilities, Fundamentals of file systems used in Windows and Linux.		2
1	**Introduction to Cybercrime and Computer-crime**	**1.1 Definition and classification of cybercrimes:** Definition, Hacking, DoS Attacks, Trojan Attacks, Credit Card Frauds, Cyber Terrorism, Cyber Stalking. **1.2 Definition and classification of computer crimes:** Computer Viruses, Computer Worms. **1.3 Prevention of Cybercrime**: Steps that can be followed to prevent cybercrime, Hackers, Crackers, Phreakers. **Self-learning Topics:** Steps performed by Hacker	1,2,3	4
2	**Introduction to Digital Forensics and Digital Evidences**	**2.1 Introduction to Digital Forensics:** Introduction to Digital Forensics and lifecycle, Principles of Digital Forensic. **2.2 Introduction to Digital Evidences:** Challenging Aspects of Digital Evidence, Scientific Evidence, Presenting Digital Evidence. **2.3 Digital Investigation Process Models:** Physical Model, Staircase Model, Evidence Flow Model. **Self-learning Topics:** Digital Investigation Process Models comparison and its application, Rules of Digital Evidence.	1,2,3	5

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3	Computer Forensics	**3.1** **OS File Systems Review:** Windows Systems-FAT32 and NTFS, UNIX File Systems, MAC File Systems	2,3,6,9	7
		3.2 Windows OS Artifacts: Registry, Event Logs		
		3.3 **Memory Forensics :** RAM Forensic Analysis, Creating a RAM Memory Image, Volatility framework, Extracting Information		
		3.4 **Computer Forensic Tools:** Need of Computer Forensic Tools, Types of Computer Forensic Tools, Tasks performed by Computer Forensic Tools		
		Self-learning Topics: Study of 'The Sleuth Kit' Autopsy tool for Digital Forensics		
4	Incident Response Management , Live Data Collection and Forensic Duplication	**4.1** **Incidence Response Methodology:** Goals of Incident Response, Finding and Hiring IR Talent	3,8	10
		4.2 **IR Process:** Initial Response, Investigation, Remediation, Tracking of Significant Investigative Information.		
		4.3 **Live Data Collection:** Live Data Collection on Microsoft Windows,		
		4.4 Forensic Duplication: Forensic Duplicates as Admissible Evidence, Forensic Duplication Tools: Creating a Forensic evidence, Duplicate/Qualified Forensic Duplicate of a Hard Drive.		
		Self-learning Topics: Live Data Collection on Unix-Based Systems		
5	Forensic Tools and Report Writing	**5.1** **Forensic Image Acquisition in Linux :** Acquire an Image with dd Tools, Acquire an Image with Forensic Formats, Preserve Digital Evidence with Cryptography, Image Acquisition over a Network, Acquire Removable Media	1,9	1 0
		5.2 **Forensic Investigation Report Writing:** Reporting Standards, Report Style and Formatting, Report Content and Organization.		
		Self-learning Topics: Case study on Report Writing		

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| 6 | Network Forensics and Mobile Forensics | **6.1 Network Forensics:** Sources of Network-Based Evidence, Principles of Internetworking, Internet Protocol Suite, Evidence Acquisition, Analyzing Network Traffic: Packet Flow and Statistical Flow, Network Intrusion Detection and Analysis, Investigation of Routers, Investigation of Firewalls

6.2 Mobile Forensics: Mobile Phone Challenges, Mobile phone evidence extraction process, Android OS Architecture, Android File Systems basics, Types of Investigation, Procedure for Handling an Android Device, Imaging Android USB Mass Storage Devices.

Self-learning Topic: Elcomsoft iOS Forensic Toolkit, Remo Recover tool for Android Data recovery | **4,5,10** | |

Recommended Books:

1. Digital Forensics by Dr. Dhananjay R. Kalbande Dr. Nilakshi Jain, Wiley Publications, First Edition, 2019.
2. Digital Evidence and Computer Crime by Eoghan Casey, Elsevier Academic Press, Third Edition, 2011.
3. Incident Response & Computer Forensics by Jason T. Luttgens, Matthew Pepe and Kevin Mandia, McGraw-Hill Education, Third Edition (2014).
4. Network Forensics: Tracking Hackers through Cyberspace by Sherri Davidoff and Jonathan Ham, Pearson Edu,2012
5. Practical Mobile Forensic by Satish Bommisetty, Rohit Tamma, Heather Mahalik, PACKT publication, Open-source publication, 2014 ISBN 978-1-78328-831-1
6. The Art of Memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory by Michael Hale Ligh (Author), Andrew Case (Author), Jamie Levy (Author), AAron Walters (Author), Publisher: Wiley; 1st edition (3 October 2014),
7. Scene of the Cybercrime: Computer Forensics by Debra Littlejohn Shinder, Syngress Publication, First Edition, 2002.
8. Digital Forensics with Open-Source Tools by Cory Altheide and Harlan Carvey, Syngress Publication, First Edition, 2011.
9. Practical Forensic Imaging Securing Digital Evidence with Linux Tools by Bruce Nikkel,NoStarch Press, San Francisco,(2016)
10. Android Forensics: Investigation, Analysis, and Mobile Security for Google Android by Andrew Hogg, Elsevier Publication,2011

Online References:

Sr. No.	Website Name
1.	https://www.pearsonitcertification.com/articles/article.aspx?p=462199&seqNum= 2

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2.	https://flylib.com/books/en/3.394.1.51/1/
3.	https://www.sleuthkit.org/autopsy/
4.	http://md5deep.sourceforge.net/md5deep.html
5.	https://tools.kali.org/
6.	https://kalilinuxtutorials.com/
7.	https://accessdata.com/product-download/ftk-imager-version-4-3-0
8.	https://www.amazon.in/Art-Memory-Forensics-Detecting-Malware/dp/1118825098

Research Papers: Mobile Forensics/Guidelines on Cell Phone Forensics

1. Computer Forensics Resource Center: NIST Draft Special Publication 800-101: https://csrc.nist.gov/publications/detail/sp/800-101/rev-1/final
2. https://cyberforensicator.com/category/white-papers
3. https://www.magnetforensics.com/resources/ios-11-parsing-whitepaper/
4. Samarjeet Yadav, Satya Prakash, Neelam Dayal and Vrijendra Singh, "Forensics Analysis WhatsApp in Android Mobile Phone", Electronic copy available at: https://ssrn.com/abstract=3576379

Course Assessment:

Theory:

ISE-1:

Activity: Quiz and assignments 20 Marks

ISE-2: Two hours 20 Marks

Activity: Article Discussion, Quiz and Assignments

Outcome: Reflective Journal

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HCSC701	Security Information Management	4	--	--	4	--	--	4
		Examination Scheme						
		Theory	ISE1	MSE	ISE2	ESE	Total	
			20	30	20	100 (30% weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course	Vulnerability Assessment for Operating Systems, Network (Wired and Wireless). Tools for conducting Reconnaissance.	
Course Outcomes	CO1	Understand the scope of policies and measures of information security to people.
	CO2	Interpret various standards available for Information security.
	CO3	Apply risk assessment methodology.
	CO4	Apply the role of access control to Identity management.
	CO5	Understand the concept of incident management, disaster recovery and business continuity.
	CO6	Identify common issues in web application and server security.

Module No.		Topics	Ref	Hours
1	1.1	What is Information Security & Why do you need it?	1, 5	6
	1.2	Basics Principles of Confidentiality, Integrity		
	1.3	Availability Concepts, Policies, procedures, Guidelines, Standards		
	1.4	Administrative Measures and Technical Measures, People, Process, Technology, IT ACT 2000, IT ACT 2008		

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2	2.1	**Cloud Computing:** benefits and Issues related to information Security.	5, 6, 7	8
	2.2	**Standards available for InfoSec:** Cobit, Cadbury, ISO 27001, OWASP, OSSTMM.		
	2.3	**An Overview, Certifiable Standards:** How, What, When, Who.		
3	3.1	**Threat Modelling:** Threat, Threat-Source, Vulnerability, Attacks.	3, 8	8
	3.2	**Risk Assessment Frameworks:** ISO 31010, NIST-SP-800- 30, OCTAVE		
	3.3	**Risk Assessment and Analysis:** Risk Team Formation, Information and Asset Value, Identifying Threat and Vulnerability, Risk Assessment Methodologies		
	3.4	Quantification of Risk, Identification of Monitoring mechanism, Calculating Total Risk and Residual Risk.		
4	4.1	Concepts of Identification, Authentication, Authorization and Accountability.	1	10
	4.2	**Access Control Models:** Discretionary, Mandatory, Role based and Rule-based.		
	4.3	**Access Control Techniques:** Constrained User, Access control Matrix, Content-dependent, Context – dependent		
	4.4	**Access Control Methods:** Administrative, Physical, Technical, Layering of Access control		
	4.5	**Access Control Monitoring:** IDS and IPS and anomaly detection		
	4.6	**Accountability:** Event-Monitoring and log reviews. Log Protection		
	4.7	**Threats to Access Control:** Various Attacks on the Authentication systems.		
5	5.1	Concept of Availability, High Availability, Redundancy and Backup.	1	10

	5.2	Calculating Availability, Mean Time Between Failure (MTBF), Mean Time to Repair (MTTR)		
	5.3	**Incident Management:** Detection, Response, Mitigation, Reporting, Recovery and Remediation		
	5.4	**Disaster Recovery:** Metric for Disaster Recovery, Recovery Time Objective (RTO), Recovery Point Objective (RPO), Work Recovery Time (WRT), Maximum Tolerable Downtime (MTD), Business Process Recovery, Facility Recovery (Hot site, Warm site, Cold site, Redundant site), Backup & Restoration		
6	6.1	Types of Audits in Windows Environment	2, 3	8
	6.2	Server Security, Active Directory (Group Policy), Anti-Virus, Mails, Malware		
	6.3	Endpoint protection, Shadow Passwords, SUDO users, etc.		
	6.4	**Web Application Security:** OWASP, Common Issues in Web Apps, what is XSS, SQL injection, CSRF, Password Vulnerabilities, SSL, CAPTCHA, Session Hijacking, Local and Remote File Inclusion, Audit Trails, Web Server Issues, etc.		

Recommended Books:

1. Shon Harris, Fernando Maymi, CISSP All-in-One Exam Guide, McGraw Hill education, 7th Edition, 2016.
2. Andrei Miroshnikov, Introduction to Information Security - I, Wiley, 2018
3. Ron Lepofsky, The Manager's Guide to Web Application Security, Apress; 1st ed. edition, 2014
4. Rich-Schiesser, IT Systems Management: Designing, Implementing and Managing World-Class Infrastructures, Prentice Hall; 2 edition, January 2010.
5. NPTEL Course: - Introduction to Information Security – I (URL: https://nptel.ac.in/noc/courses/noc15/SEM1/noc15-cs03/)
6. Dr. David Lanter – ISACA COBIT – 2019 Framework - Introduction and Methodology Pete Herzog, OSSTMM 3, ISECOM
7. NIST Special Publication 800-30, Guide for Conducting Risk Assessments, September 2012
8. https://www.ultimatewindowssecurity.com/securitylog/book/Default.aspx
9. http://www.ala.org/acrl/resources/policies/chapter14
10. https://advisera.com/27001academy/what-is-iso-27001/
11. https://nvlpubs.nist.gov/nistpubs/legacy/sp/nistspecialpublication800-30r1.pdf
12. http://www.diva-portal.org/smash/get/diva2:1117263/FULLTEXT01.pdf

Course Assessment:

Theory:

ISE-1:

Activity: Quiz and assignments 20 Marks

ISE-2: Two hours 20 Marks

Activity: Article Discussion, Quiz and Assignments

Outcome: Reflective Journal

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
HCSSBL601	Vulnerability Assessment Penetration Testing (VAPT) Lab	L	T	P	L	T	P	Total
		4	--	--	4	--	--	4
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	20	--	30	--	50	

Pre-requisites		CSC503, Basic of Network Security.
Course Outcomes	1	Understand the structure where vulnerability assessment is to be performed.
	2	Apply assessment tools to identify vulnerabilities present in the system in network.
	3	Evaluate attacks by executing penetration tests on the system or network.
	4	Analyse a secure environment by improving security controls and applying prevention mechanisms for unauthorised access to database.
	5	Create security by testing and exploit systems using various

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		tools and remove the impact of hacking in system.
	6	Formation of documents as per applying the steps of vulnerabilities of assessment and penetration testing.

Sr. No.	Module	Topics	Ref.	Hours.
1	**Human Security (Social Engineering) Assessment**	**Visibility Audit:** Collecting information through social media and internet. Collecting contact details (like phone number, email ID, What's App ID, etc) **Active Detection Verification:** Test if the phone number, email id etc are real by test message. Test whether the information is filtered at point of reception. Test if operator / another person assistance can be obtained. **Device Information:** IP Address, Port details, Accessibility, Permissions, Role in business **Trust Verification:** Test whether the information can be planted in form of note / email / Message (Phishing) **Test Subjects:** College Staff, Reception, PA to Director / Principal. To conduct information gathering to conduct social engineering audit on various sections in your college. **Self-Learning Topics:** Networking Commands	1,2	8
2	**Network & Wireless Security Assessment**	**Network Discovery:** Using various tools to discover the various connected devices, to get device name, IP Address, relation of the device in network, Detection of Active port, OS Fingerprinting, Network port and active service discovery **Tools:** IP Scanner, Nmap etc **Network Packet Sniffing**: Packet Sniffing to detect the traffic pattern, Packet capturing to detect protocol specific traffic pattern, Packet capturing to reassemble packet to reveal unencrypted password	1,2	8

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		Tools: Wireshark **Self-Learning Topics**: Learning the CVE database for vulnerabilities detected.		
3	**Setting up Pentester lab**	Including an attacker machine preferably Kali and in the same subnet victim machines either DVWA/ SEEDlabs/ multiple VULNHUB machines as and when required. Understanding Categories of pentest and legalities/ ethics. Installed Kali machine on VM environment with some VULNHUB machines and we can find out vulnerability of Level 1-VULNHUB machine like deleted system files, permissions of files. **Self-learning Topics:** Vulnerability exploitation for acquire root access of the Kioptrx machine	1,2	9
4	**Database and Access** **Control Security Assessment**	**Database Password Audit:** Tool based audit has to be performed for strength of password and hashes. Tools: DBPw Audit **Blind SQL Injection**: Test the security of the Database for SQL Injection **Tools**: BSQL Hacker **Password Audit**: Perform the password audit on the Linux / Windows based system **Tools**: Cain & Able, John the ripper, LCP Password Auditing tools for Windows. **Active Directory and Privileges Audit**: Conduct a review of the Active Directory and the Group Policy to assess the level of access privileges allocated. **Tools**: SolarWinds	1,2	9

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		Self-Learning Topics: Federated Database security challenges and solutions.		
5	Log Analysis	Conduct a log analysis on Server Event Log / Firewall Logs/ Server Security Log to review and obtain insights Tools: graylog, Open Audit Module. Self-Learning Topics: Python and R-Programming scripts	1,2	6
6	Compliance and Observation Reporting	License Inventory Compliance: Identify the number of licenses and its deployment in your organization. Tools: Belarc Advisor, Open Audit Report Writing: NESSUS tool Report should contain: a. Vulnerability discovered b. The date of discovery c. Common Vulnerabilities and Exposure (CVE) database reference and score; those vulnerabilities found with a medium or high CVE score should be addressed immediately d. A list of systems and devices found vulnerable e. Detailed steps to correct the vulnerability, which can include patching and/or reconfiguration of operating systems or applications f. Mitigation steps (like putting automatic OS updates in place) to keep the same type of issue from happening again Purpose of Reporting: Reporting provides an organization with a full understanding of their current security posture and what work is necessary to both fix the potential threat and to mitigate the same source of vulnerabilities in the future. Self-Learning Topics: Study of OpenVAS, Nikto, etc.	1,2	10
			Total	50

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Course Assessment:

Lab:

ISE:

1. **ISE-1** Quizzes/Assignments/Paper Presentation/Article Discussion
   Quizzes/Assignments based on 50% experiments
2. **ISE-2** Quizzes/Assignments/Paper Presentation/Article Discussion
   Quizzes/Assignments based on 50% experiments

Recommended Books:

1. The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws
   Paperback – Illustrated, 7 October 2011 by Dafydd Stuttard
2. Hacking: The Art of Exploitation, 2nd Edition 2nd Edition by Jon Erickson

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HCSC801	**Application Secretary**	4	--	--	4	--	--	4
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisites	CSC404, CSC403, CSC503, CSDLO5012, CSC304, CSC405	
Course Outcomes	CO1	Enumerate the terms of application Security, Threats, and Attacks
	CO2	Describe the countermeasures for the threats with respect to Application security.
	CO3	Discuss the Secure Coding Practices.
	CO4	Explain the Secure Application Design and Architecture.
	CO5	Review the different Security Scanning and testing techniques.
	CO6	Discuss the threat modeling approaches.

Module No.	Unit No.	Topics	Ref.	Hours.
1	1.1	Introduction to Web Application Reconnaissance, Finding Subdomains, API Analysis, Identifying Weak Points in Application Architecture	3	5
	1.2	**Offense:** Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), XML External Entity (XXE) Injection, Injection Attacks, Denial of Service (DoS), Cross-Origin Resource Sharing Vulnerabilities		

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2	2.1	Securing Modern Web Applications, Secure Application Architecture, Reviewing Code for Security, Vulnerability Discovery, Defending Against XSS Attacks, Defending Against CSRF Attacks, Defending Against XXE, Defending Against Injection attacks, Defending Against DoS, Defending against CORS based attacks	3	9
3	3.1	Security Requirements, Encryption, Never Trust System Input, Encoding and Escaping, Third-Party Components, Security Headers: Seatbelts for Web Apps, Securing Your Cookies, Passwords, Storage, and Other Important Decisions, HTTPS Everywhere, Framework Security Features, File Uploads, Errors and Logging, Input Validation and Sanitization,Authorization and Authentication, Parameterized Queries, Least Privilege, Requirements Checklist	1	9
4	4.1	**Secure Software Development Lifecycle:** Averting Disaster Before It Starts, Team Roles for Security, Security in the Software Development Lifecycle,	4,6, 9	9
	4.2	**Design Flaw vs. Security Bug**		
	4.3	**Secure Design Concepts**		
	4.4	**Segregation of Production Data, Application Security Activities**		
5	5.1	Testing Your Code, Testing Your Application, Testing Your Infrastructure, Testing Your Database, Testing Your APIs and Web Services, Testing Your Integrations, Testing Your Network, Dynamic Web Application Profiling	2,7	9
6	6.1	**Objectives and Benefits of Threat Modeling:** Defining a Risk Mitigation Strategy, Improving Application Security, Building Security in the Software Development Life Cycle	5	9
	6.2	**Existing Threat Modeling Approaches:** Security, Software, Risk-Based Variants		
	6.3	**Threat Modeling Within the SDLC:** Building Security in SDLC with Threat Modeling, Integrating Threat Modeling Within the Different Types of SDLCs,		
			Total	**50**

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Recommended Books:

1. Alice and Bob Learn Application Security, by Tanya Janca Wiley; 1st edition (4 December 2020)
2. Web Application Security, A Beginner's Guide by Bryan Sullivan McGraw-Hill Education; 1st edition (16 January 2012)
3. Web Application Security: Exploitation and Countermeasures for Modern Web Applications by Andrew Hoffman Shroff/O'Reilly; First edition (11 March 2020)
4. The Security Development Lifecycle by Michael Howard Microsoft Press US; 1st edition (31 May 2006)
5. Risk Centric Threat Modeling Process for Attack Simulation And Threat Analysis, Tony Ucedavélez and Marco m. Morana, Wiley
6. Iron-Clad Java: Building Secure Web Applications (Oracle Press) 1st Edition by Jim Manico

Course Assessment:

Theory: ISE-1: Activity: Quiz and assignments 20 Marks

ISE-2: Two hours 20 Marks Activity: Article Discussion, Quiz and Assignments

Outcome: Reflective Journal

MSE: Two hours 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

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3D Printing

SEM-V, VI, VII & VIII										
Course Code	Course Name		Contact Hours	Examination Marks					Credits	
				ISE1	MSE	ISE2	ESE	Total	Points	Total
H3DPC501	Introduction to CAD	TH	4	20	30	20	30	100	4	4
H3DPC601	3D printing: Introduction and Processes	TH	4	20	30	20	30	100	4	4
H3DPC701	Applications of 3D Printing	TH	4	20	30	20	30	100	4	4
H3DPSBL701	Skill based Lab- Digital Fabrications	PR	4	20	-	30	-	50	2	2
H3DPC801	3D Printing in Medical Technology	TH	4	20	30	20	30	100	4	4
	Total		TH:TU:PR 12:0:4=16			-	-	450	-	18

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
H3DPC501	**Introduction to CAD**	4	--	--	4	--	-	4
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100 (30% weightage)		100

Pre-requisite Course Codes	
Course Outcomes	CO1 — Illustrate basic understanding of design.
	CO2 — Create the CAM Toolpath for specific given operations.
	CO3 — Illustrate basic understanding of types of CAD model creation.
	CO4 — Generate assembly models of given objects using assembly tools of a modelling software.
	CO5 — Identify suitable computer graphics techniques for 3D modelling.
	CO6 — Transform, manipulate objects & store and manage data.

Module	Detailed Content	Hours
1	**Design thinking:** Identification of need, Embodiment of design, Generation of ideas and research topics	05
2	**Subtractive Manufacturing:** Introduction to NC/CNC/DNC machines **Additive Manufacturing:** Introduction to 3D Printing, Limitations of Subtractive manufacturing, Digital fabrication	08
3	**CAD Introduction:** History & Scope of CAD, CAD hardware and software, Advantages, Disadvantages and Applications of CAD	07

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4	**Introduction to 2D modelling:** CAD models Creation, Types, and uses of models from different perspectives **Introduction to assembly drawing:** Types of assembly drawings, part drawings, drawings for catalogues and instruction manuals, patent drawings, drawing standards	**12**
5	**Computer Graphics:** Overview of 2D and 3D Computer Graphics, Parametric representation of curves: Synthetic Curves - Bezier curves, Hermite Curves, B-spline curves **Geometric Modelling:** Wire Frame Modelling, Solid Modelling, Surface Modelling, Parametric Modelling, Feature based Modelling, Constraint Based Modelling.	**12**
6	**Geometric Transformation:** 2D & 3D Transformations (Translation, Rotation, & Scaling & Reflection), Concatenations	**08**

Recommended Books:
1. Machine Drawing by N.D. Bhatt.
2. A textbook of Machine Drawing by Laxminarayan and M.L.Mathur, Jain brothers Delhi
3. CAD/ CAM, Theory & Practice, Ibrahim Zeid, R. Sivasubramanian, Tata McGraw Hill Publications
4. CAD/CAM Principles and Applications, P. N. Rao, Tata McGraw Hill Publications
5. CAD/CAM Computer Aided and Manufacturing, Mikell P. Groover and Emory W. Zimmers, Jr., Eastern Economy Edition
6. CNC Technology and Programming, Krar, S., and Gill, A., McGraw Hill Publishers.
7. Medical Modelling The Application of Advanced Design and Rapid Prototyping Techniques in Medicine, Richard Bibb, Dominic Eggbeer and Abby Paterson, Woodhead Publishing Series in Biomaterials: Number 91, Elsevier Ltd.
8. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, I. Gibson l D. W. Rosen l B. Stucker, Springer Publication.

Course Assessment:

Theory:
ISE-1: Presentation on case studies based on the first three modules or one assignment each on first three modules or quiz (20 marks).
ISE-2: Presentation on case studies based on the last three modules or one assignment each on last three modules or quiz (20 marks).
MSE: Two hours of written examination based on 50% syllabus (30 Marks)
ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
H3DPC601	3D Printing: Introduction & Processes	4	--	--	4	--	-	4
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	

Pre-requisite Course Codes		
Course Outcomes	CO1	Illustrate understanding of various cost-effective alternatives for manufacturing products and select the feasible RP process for specific technical applications
	CO2	Build and create data for 3D printing of any given object using liquid based rapid prototyping and tooling processes
	CO3	Build and create data for 3D printing of any given object using solid based rapid prototyping and tooling processes
	CO4	Build and create data for 3D printing of any given object using powder based rapid prototyping and tooling processes
	CO5	Select an appropriate material and tools to develop a given product using rapid prototyping machine
	CO6	Select proper rapid prototyping and reverse engineering techniques for specific technical applications and demonstrate basics of virtual reality

Module	Detailed Content	Hours
1	**Additive Manufacturing:** Introduction to AM, Classification of AM Processes, Advantages & disadvantages, AM Applications; in Design, Concept Models, Form & fit checking, Functional testing, CAD data verification, Rapid Tooling, and bio fabrication.	09
2	**Liquid based systems:** **Stereo lithography apparatus (SLA):** Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. **Solid ground curing (SGC):** Models and specifications, process, working, principle, applications, advantages and disadvantages, case studies.	09
3	**Solid based systems:** **Laminated object manufacturing (LOM):** Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies. **Fused Deposition Modeling (FDM):** Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies.	08
4	**Powder Based Systems:** **Selective laser sintering (SLS):** Models, specifications, process, working principle, applications, advantages and disadvantages, case studies. **Three-dimensional printing (3DP):** Models and specification, process, working principle, applications, advantages, disadvantages, case studies.	08

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	Electron Beam Melting (EBM): Models and specification, process, working principle, applications, advantages, disadvantages, case studies.	
5	**Materials for Additive manufacturing** Types of material: polymers, metals, ceramics, composites, liquid-based materials, photo polymer development, solid & powder-based materials. **Material properties** Colour, dimensional accuracy, stability, surface finish, machinability, environmental resistance, operational properties.	10
6	**Reverse Engineering** Introduction to Digitizing Methods, Contact type and Non-contact type, Brief introduction to the types of medical imaging. Virtual reality: Definition, features of VR, Technologies used in VR, Introduction to Augmented reality	08

Recommended Books:
1. Rapid Prototyping, Principles and Applications by Rafiq I. Noorani, Wiley & Sons.
2. Rapid Prototyping: Principles and Applications by Chua C.K, Leong K.F and Lim C.S, 2nd Edition, World Scientific.
3. Rapid Manufacturing – An Industrial revolution for the digital age by N.Hopkinson, R.J. M. Hauge, P M, Dickens, Wiley.
4. Advanced Manufacturing Technology for Medical applications: Reverse Engineering, Software conversion and Rapid Prototyping by Ian Gibson, Wiley.
5. Rapid Prototyping and Manufacturing: Fundamentals of Stereolithography by Paul F. Jacobs, McGraw Hill.
6. Rapid Manufacturing by Pham D T and Dimov S S, Springer Verlog.
7. Rapid Prototyping by Chee Kai Chua, World Scientific Publishing.

Course Assessment:

Theory:
- **ISE-1:** Presentation on case studies based on the first three modules or one assignment each on first three modules or quiz (20 marks).
- **ISE-2:** Presentation on case studies based on the first three modules or simulation on 3d printing component or quiz (20 marks).
- **MSE:** Two hours of written examination based on 50% syllabus **(**30 Marks)
- **ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
H3DPC701	Applications of 3D Printing	L	T	P	L	T	P	Total
		4	--	--	4	--	-	4
		Examination Scheme						
		Theory	ISE1	MSE	ISE2	ESE	Total	
			20	30	20	100 (30% weightage)	100	

Pre-requisite Course Codes		
	CO1	To understand the perspectives for 3D printing in Jewellery industries for selection of an appropriate material and tools to develop a given product using rapid prototyping techniques.
	CO2	Develop 3D model using various types of available biomedical data.
	CO3	To understand the perspectives for 3D printing in Aerospace industries for selection of an appropriate material and tools to develop a given product using rapid prototyping techniques.
Course Outcomes	CO4	Illustrate understanding of various cost-effective alternatives for manufacturing products.
	CO5	Use rapid prototyping and tooling concepts in any real-life applications.
	CO6	Contribute towards the Product Development at the respective domain in the industry

Module	Detailed Content	Hours
1	**Applications in Jewellery Industries** **Introduction to 3D Printing Jewellery:** Steps Involved in Jewellery 3D Printing, Why 3D Printing for Jewellery Making, Techniques Involved in Jewellery 3D Printing, 3D Printing Processes for Jewellery Designing, Challenges with Jewellery 3D Printing, 3D Printing vs Traditional Methods, Types of Jewellery can be 3D Printed. **3D Printers for Jewellery Making –** How They Work & Which to Choose	10
2	**Medical Applications in Additive manufacturing** Presurgical Planning Models, Mechanical Bone Replicas, Teaching Aids and Simulators, Customized Surgical Implants, Prosthetics and Orthotics', Anthropology, Forensics.	08
3	**Applications in Aerospace Industries** Use of AM in Aerospace, Metal AM in Aerospace, Super alloys, Non-Destructive Evaluation, Space technology.	08
4	**Applications in Tooling** **Methods of Rapid tooling:** Direct Soft Tooling, Indirect Soft Tooling, Direct Hard Tooling, Indirect Hard Tooling.	09
5	**Applications in various industries** Automotive, Défense, Coin industries, Household appliance, Toy industry, Ship	09

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	building, Un-manned Aerial Vehicles (UAV), Furniture, Construction and food	
6	**Applications in Design** Design for Additive Manufacturing (DFAM), Topology optimization for AM, Generative design. **Applications in Engineering, Analysis and Planning**	**08**

Recommended Books:
1. Makers: The New Industrial Revolution (Telord 1403), by Chris Anderson
2. Medical Modelling The Application of Advanced Design and Rapid Prototyping Techniques in Medicine, Richard Bibb, Dominic Eggbeer and Abby Paterson, Woodhead Publishing Series in Biomaterials: Number 91, Elsevier Ltd.
3. 3D Printing in Aerospace and Defense Standard Requirements, by Gerardus Blokdyk
4. Additive Manufacturing for the Aerospace Industry, by Francis Froes, Rodney Boyer
5. 3D Printing in Medicine, 1st Edition - April 1, 2017, by Deepak Kalaskar
6. An Update on Medical 3D Printing Hardcover – 1 January 2019, by Dr Raju Vaishya, Dr Abid Haleem, Dr Lalit Maini
7. 3D Printing in Medicine: A Practical Guide for Medical Professionals Hardcover – Import, 12 October 2017, by Frank J. Rybicki, Gerald T. Grant
8. Rapid Prototyping, Principles and Applications by Rafiq I. Noorani, Wiley & Sons
9. Rapid Prototyping: Principles and Applications by Chua C.K, Leong K.F and Lim C.S, 2nd Edition, World Scientific
10. Rapid Manufacturing – An Industrial revolution for the digital age by N.Hopkinson, R.J. M. Hauge, P M, Dickens, Wiley
11. Advanced Manufacturing Technology for Medical

Course Assessment:

Theory:
- **ISE-1:** Presentation on case studies based on the first three modules or one assignment each on first three modules or quiz (20 marks).
- **ISE-2:** Presentation on case studies based on the last three modules or one assignment each on last three modules or quiz (20 marks).
- **MSE:** Two hours of written examination based on 50% syllabus **(**30 Marks)
- **ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
H3DPC801	**3D Printing in Medical Technology**	4	--	--	4	--	-	4
		Examination Scheme						
		Theory	ISE1	MSE	ISE2	ESE	Total	
			20	30	20	100 (30% weightage)	100	

Pre-requisite Course Codes			
Course Outcomes	CO1	Describe the creation of highly accurate physical models of human anatomy	
	CO2	Identify medical imaging for human body	
	CO3	Understand the modelling based on Biomedical data	
	CO4	Build and create data for 3D printing of any given object using rapid prototyping and tooling processes.	
	CO5	Illustrate the understanding of different manufacturing processes	
	CO6	To Identify the processes and tooling concepts in Biomedical	

Module	Detailed Content	Hours
1	**Introduction** Stages of the medical modelling process, The human form, Basic anatomical terminology, technical terminology	**08**
2	**Introduction to medical imaging** Computed tomography (CT), Cone beam CT (CBCT), Magnetic resonance (MR), Noncontact surface scanning, Medical scan data, Point cloud data	**10**
3	**Working with medical scan data** Pixel data operations, Using CT data: a worked example, Point cloud data operations, Two-dimensional formats, Pseudo 3D formats, True 3D formats, File management and exchange	**12**
4	**Physical reproduction** Basic principles of medical modelling: orientation, sectioning, separating and joining, trapped volumes	**08**
5	Introduction to Additive manufacturing processes used for Bio-Modelling, Computer numerical controlled machining, Cleaning and Sterilizing medical models	**08**
6	Case Studies based on Bio-Modelling & Future Development	**06**

Recommended Books:
1. Medical Modelling The Application of Advanced Design and Rapid Prototyping Techniques in Medicine, Richard Bibb, Dominic Eggbeer and Abby Paterson, Woodhead Publishing Series in Biomaterials: Number 91, Elsevier Ltd.
2. 3D Printing in Medicine, 1st Edition - April 1, 2017, by Deepak Kalaskar
3. An Update on Medical 3D Printing Hardcover – 1 January 2019, by Dr Raju Vaishya, Dr Abid Haleem, Dr Lalit Maini

4. 3D Printing in Medicine: A Practical Guide for Medical Professionals Hardcover – Import, 12 October 2017, by Frank J. Rybicki, Gerald T. Grant

5. Rapid Prototyping, Principles and Applications by Rafiq I. Noorani, Wiley & Sons

6. Rapid Prototyping: Principles and Applications by Chua C.K, Leong K.F and Lim C.S, 2nd Edition, World Scientific

7. Advanced Manufacturing Technology for Medical applications: Reverse Engineering, Software conversion and Rapid Prototyping by Ian Gibson, Wiley

Course Assessment:

Theory:

ISE-1: Presentation on case studies based on the first three modules or one assignment each on first three modules or quiz (20 marks).

ISE-2: Presentation on case studies based on the last three modules or one assignment each on last three modules or quiz (20 marks).

MSE: Two hours of written examination based on 50% syllabus (30 Marks)

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
H3DPSBL701	Skill Based Lab – Digital Fabrication	L	T	P	L	T	P	Total
		--	--	4	--	--	2	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes			
Course Outcomes		CO1	Illustrate basic understanding of types of CAD model creation.
		CO2	Build geometric model of a given object using 3D modelling software
		CO3	Generate assembly models of given objects using assembly tools of a modelling software
		CO4	Demonstrate CAM Tool path and prepare NC- G code
		CO5	Develop 3D model using available biomedical data

Sr. No.	Contents	Hours
1	Geometric modeling of an Engineering component, demonstrating skills in sketching commands of creation (line, arc, circle etc.) modification (Trim, move, rotate etc.) and viewing using (Pan, Zoom, Rotate etc.)	06
2	Demonstrating modeling skills using commands like Extrude, Revolve, Sweep, Blend, Loft etc. Mesh of curves, free form surfaces etc. Feature manipulation using Copy, Edit, Pattern, Suppress, History operations etc.	04

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3	Assembly: Constraints, Exploded views, interference check. Drafting (Layouts, Standard & Sectional Views, Detailing & Plotting).	04
4	Solid modeling of any engineering component using any 3D modeling software.	04
5	Non - Contact Scanning – Generation of CAD model using 3D scanning equipment.	04
6	Reverse Engineering of a legacy component – Selection of components, 3D scanning, CAD model verification, 3D print of CAD model.	04
7	Modeling of a component using 3D modelling software and development of G – Code output using Fractal Software.	06
8	Design an object with free form surface using Autodesk Fusion 360 and development of G – Code output using Fractal Software.	04
9	Segmentation in Slicer's Segment Editor module for the purpose of 3D printing.	04
10	Creation of 3D model from 2D images using any image processing software and printing it. (3D Slicer open source) (Application: Any body organ like Heart, Gallbladder etc. as per available Dicom files)	04
11	Development of physical 3D mechanical structure using any one of the Additive manufacturing processes – Material to be used Metal	06
12	Development of physical 3D mechanical structure using any one of the Additive manufacturing processes - Material to be used Plastic	04

Course Assessment:

Laboratory work:
1. **ISE-1 (20 marks)**
2. **ISE-2 (30 marks)**
   i. Submission of the observations made during the lab performance for the last 6 experiments covered during this assessment duration. Assessment will be based on pre-defined rubrics (20 marks).
   ii. Lab interaction: (10 marks)

Recommended Books:
1. Machine Drawing by N.D. Bhatt.
2. A textbook of Machine Drawing by Laxminarayan and M.L.Mathur, Jain brothers Delhi
3. Machine Drawing by K.I. Narayana, P. Kannaiah, K.Venkata Reddy
4. Medical Modelling - The Application of Advanced Design and Rapid Prototyping Techniques in Medicine, Richard Bibb, Dominic Eggbeer and Abby Paterson, Woodhead Publishing Series in Biomaterials: Number 91, Elsevier Ltd
5. Biomaterials, artificial organs and tissue engineering, Edited by Larry L. Hench and Julian R. Jones, Woodhead Publishing and Maney Publishing, CRC Press 2005
6. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, I. Gibson l D. W. Rosen l B. Stucker, Springer Publication.

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Robotics

SEM-V, VI, VII & VIII										
Course Code	**Course Name**		**Contact Hours**	**Examination Marks**					**Credits**	
				ISE1	MSE	ISE2	ESE	Total	Points	Total
HRBCC501	Industrial Robotics	TH	4	20	30	20	30	100	4	4
HRBC601	Mechatronics & IoT	TH	4	20	30	20	30	100	4	4
HRBC701	Artificial Intelligence and Data Analytics	TH	4	20	30	20	30	100	4	4
HRBSBL701	Robotics and Automation Lab	PR	4	20	-	30	-	50	2	2
HRBC801	Autonomous Vehicle Systems	TH	4	20	30	20	30	100	4	4
Total			**TH:TU:PR 12:0:4=16**			-	-	450	-	18

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		4	-	-	4	-	-	4
HRBC501	**Industrial Robotics**	**Examination Scheme**						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	

Pre-requisite Course Codes			
Course Outcomes	CO1	Acquire skills in understanding robot language and programming	
	CO2	Acquire skills in robot task planning for problem solving	
	CO3	Develop skills in understanding various sensors, robot peripherals and their use and deployment in manufacturing systems	
	CO4	Develop skills in identifying areas in manufacturing where robotics can be deployed for enhancing productivity	

Module	Detailed Content	Hours
1	**Introduction to Automation:** robotics, Robotic system & Anatomy, Classification and Future Prospects	02
2	**Drives** Control Loops, Basic Control System Concepts & Models, Control System Analysis, Robot Activation & Feedback Components, Position & Velocity Sensors, Actuators and Power Transmission system. **Robot & its Peripherals** **End Effecters:** Type mechanical and other grippers, Tool as end effecter. **Sensors:** Sensors in Robotics, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems, Vision systems and Equipment	10
3	**Machine vision** Introduction, Low level & High level Vision, Sensing & Digitizing, Image Processing & analysis, Segmentation, Edge detection, Object Description & recognition, interpretation and Applications.	10

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	Programming for Robots Method, Robot Programme as a path in space, Motion interpolation, motion & task level Languages, Robot languages, Programming in suitable languages and characteristics of robot.	
4	**Robot Kinematics:** Forward, reverse & Homogeneous Transformations, Manipulator Path control and Robot Dynamics. Introduction to wheeled and legged robots including humanoids	**10**
5	**Robot Intelligence & Task Planning:** Introduction, State space search, Problem reduction, use of predictive logic, Means. Ends, Analysis, Problem solving, Robot learning and Robot task planning.	**10**
6	**Robot application in manufacturing:** Material transfer, machine loading & unloading, processing operation, Assembly & inspectors, robotic Cell design & control, Social issues & Economics of Robotics.	**10**

Recommended Books:

1. Industrial Robotics, Technology, Programming & Applications, Grover, Weiss, Nagel,

Ordey, Mc Graw Hill.

2. Robotics: Control, Sensing, Vision & Intelligence, Fu, Gonzalex, Lee, Mc Graw Hill.

3. Robotic technology & Flexible Automation, S R Deb. TMH.

4. Robotics for Engineers, Yoram Koren , Mc Graw hill.

5. Fundamentals of Robotics, Larry Health.

6. Robot Analysis & Control, H Asada, JJE Slotine.

7. Robot Technology, Ed. A Pugh, Peter Peregrinus Ltd. IEE, UK. 8. Handbook of Industrial Robotics, Ed. Shimon. John Wiley

8. Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA

Course Assessment:

Theory:
   ISE-1:   Quizzes (10 Marks), Assignments (10 Marks)
   ISE-2:   Assignment (10 Marks), Simulation based problem solving (10 Marks)
   MSE: Two hours of written examination based on 50% syllabus **(**30 Marks)
   ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HRBC601	Mechatronics & IoT	4	-	-	4	-	-	4
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	

Pre-requisite Course Codes		
Course Outcomes	CO1	Describe a Mechatronic System
	CO2	Demonstrate the use of a Micro-controller
	CO3	Understand an IOT System
	CO4	Identify Wireless Technologies Supporting IOT
	CO5	Use Data Analytics in conjunction with IOT &Cloud

Module	Detailed Content	Hours
1	**Introduction to Mechatronics:** Traditional and Mechatronics Design, Mechatronics Key Elements, Basic Components of Mechatronic Systems , Integrated Design issues in Mechatronics, Mechatronics Design Process, Mechatronics System in Factory, Home and Business Applications, Objectives, Advantages and Disadvantages of Mechatronics	06
2	**Overview of Micro-processor ad Micro-controller**: 8051 Micro-controllers, Functional Block Diagram and Architecture, Instruction set and Assembly Language Programming, Analog and Data Acquisition , Digital I/O interfacing, Special Function interfacing, Signal Conditioning, Special Utility Support hardware Interfacing of HEX – Keyboards, LCD Display, ADC, DAC and Stepper Motor with 8051 Micro-controller	10
3	**Introduction and application to Internet of Things:** Need of IoT, history of IOT, Objects of IOT, Level of IOT, Technologies in IOT, Introduction to Arduino and Raspberry Pi, understanding its components, recognizing the Input/Output, GPIO Connectivity	10
4	**Wireless Technologies Supporting IoT:** Protocol Standardization for IoT, Machine to machine (M2M) and WSN protocols, Basics of RFID , RFID Protocols, Issues with IOT Saudization, Protocols – IEEE 802.15.4, Zigbee, IPv6 Technologies for IOT	10
5	**Data Analytics for IOT:** Introduction Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Real Tie Data Analysis, Structural Health Monitoring, Case Study: Chef Case Study, puppet Case Study	10
6	**Introduction to Cloud Computing:** Difference between Cloud Computing and FOG Computing: The Next Evolution of Cloud Computing, Role of Cloud Computing in IOT, Connecting IoT to Cloud, Cloud Storage for IoT Challenge in Integration of IoT with Cloud	06

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Recommended Books:

1. Bolton, William. Mechatronics: electronic control systems in mechanical and electrical engineering. Pearson Education, 2003.

2. De Silva, Clarence W. Mechatronics: an integrated approach. CRC press, 2004.

3. Ayala, Kenneth J. The 8051 microcontrollers. Thomson Delmar Learning, 2005.

4. Zhang, Dan, and Bin Wei, eds. Mechatronics and Robotics Engineering for Advanced and Intelligent Manufacturing. Springer International Publishing, 2017.

5. Greengard, Samuel. The internet of things. MIT press, 2021.

6. Chaouchi, Hakima, ed. The internet of things: Connecting objects to the web. John Wiley & Sons, 2013.

7. Hintz, Kenneth, and Daniel Tabak. Microcontrollers: architecture, implementation, and programming. McGraw-Hill, Inc., 1992.

Course Assessment:

Theory:
    ISE-1:   Quizzes (10 Marks), Assignments (10 Marks)
    ISE-2:   Assignment (10 Marks), Simulation based problem solving (10 Marks)
    MSE: Two hours of written examination based on 50% syllabus **(**30 Marks)
    ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HRBC701	**Artificial Intelligence and Data Analytics**	4	-	-	4	-	-	4
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	

Pre-requisite Course Codes			
Course Outcomes	CO1	Demonstrate knowledge of the building blocks of AI, intelligent agents and knowledge presentation systems	
	CO2	Explain artificial intelligence planning, reasoning, uncertainty handing and expert systems	
	CO3	Describe the concept of data mining, big data, data analytics, business intelligence	
	CO4	Comprehend and implement data mining and machine learning algorithms	

Module	Detailed Content	Hours
1	**Introduction to Artificial Intelligence (AI):** A. I. Representation, Representation of knowledge, knowledge base systems, state space search, production systems, problem characteristics, types of production systems, Intelligent Agents and Environments, nature of environments, structure of agents **Knowledge and Reasoning:** Knowledge Representation Systems, Properties of Knowledge Representation Systems, Propositional Logic (PL), First Order Logic: Syntax and Semantic, Inference in FOL, Forward v/s Backward Chaining	06
2	**Planning:** Introduction to Planning, Planning with State Space Search, Partial Ordered planning, Hierarchical Planning, Conditional Planning, Brief introduction to single layer and multiplayer networks **Reasoning Under Uncertainty:** Handling Uncertain Knowledge, Random Variables, Prior and Posterior Probability, Inference using Full Joint Distribution, Bayes' Rule and its use, Bayesian Belief Networks, Reasoning in Belief Networks **Introduction to Expert Systems:** Components of Expert System: Knowledge base, Inference engine, user interface, working memory, Development of Expert Systems	10
3	**Introduction to Data Mining:** What is Data Mining; Kind of patterns to be mined; Technologies used; Major issues in Data Mining, associative Rule Mining **Introduction to Big Data:** Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Case Studies of Big Data Solutions, Introduction to parallel Processing (MPP) architecture, Hadoop/HDFS and cloud-based solutions **Introduction to Business Intelligence:** Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	08
4	**Data Pre-processing:** Notion of data quality. Typical pre-processing operations: combining values into one, handling incomplete/ incorrect / missing values, recoding values, sub setting, sorting, transforming scale, determining percentiles, removing noise, removing inconsistencies, transformations, standardizing, normalizing - min-max normalization, z-score standardization. **Data Modeling and visualization:** Logic driven modeling, data driven modeling, basic what-if spreadsheet models	10

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	Data Warehousing: What is a data warehouse, need for a data warehouse, architecture, data marts, OLTP vs OLA	
5	**Machine Learning:** Supervised and Unsupervised Learning, Concepts of Classification, Clustering and prediction **Performance Measures:** Measuring Quality of model- Confusion Matrix, Accuracy, Recall, Precision, Specificity, F1 Score, RMSE	08
6	**Classification:** Rule based classification, classification by Bayesian Belief networks, Hidden Markov Models. **Clustering:** Hebbian Learning rule, Expectation -Maximization algorithm for clustering **Dimensionality Reduction:** Principal Component Analysis Feature Selection and Feature Extraction **Time Series Analysis and Forecasting:** Time series patterns, forecast accuracy, moving averages and exponential smoothing	10

Recommended Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach —Second Edition" Pearson Education.

2. Elaine Rich and Kevin Knight —Artificial Intelligence‖ Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.

3. George F Luger "Artificial Intelligence" Low Price Edition, Pearson Education, Fourth edition.

4. Deepak Khemani, A first course in Artificial Intelligence, Mc GrawHill

5. P. N. Tan, M. Steinbach, Vipin Kumar, "Introduction to Data Mining", Pearson Education.

6. G. Shmueli, N.R. Patel, P.C. Bruce, "Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner", 2nd Edition, Wiley India.

7. Ethem Alpaydın, "Introduction to Machine Learning", MIT Press

8. Peter Flach, "Machine Learning", Cambridge University Press

9. Tom M. Mitchell, "Machine Learning", McGraw Hill

10. Kevin P. Murphy, "Machine Learning — A Probabilistic Perspective", MIT Press

11. Stephen Marsland, "Machine Learning an Algorithmic Perspective", CRC Press

12. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning", Cambridge University Press

13. Peter Harrington, "Machine Learning in Action", DreamTech Press

14. D. W. Patterson, Artificial Intelligence and Expert Systems, Prentice Hall.

15. Saroj Kaushik "Artificial Intelligence", Cengage Learning

Course Assessment:

ISE1 : Quizzes (10 Marks), Assignments (10 Marks)

ISE-2: Assignment (10 Marks), Simulation based problem solving (10 Marks)

MSE: Two hours of written examination based on 50% syllabus **(**30 Marks)

ESE: Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
HRBC801	Autonomous Vehicle Systems	L	T	P	L	T	P	Total
		4	-	-	4	-	-	4
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	

Pre-requisite Course Codes	
Course Outcomes	CO1	Gain perspective of autonomous systems
	CO2	Understand Automotive Electronics and the operation of ECUs
	CO3	Discuss about the use of computer vision and learning algorithms in vehicles.
	CO4	Learn Localization, Perception, Prediction planning and control
	CO5	Summarize the aspects of connectivity
	CO6	Understand cloud platform and ROS

Module	Detailed Content	Hours
1	**An over view of autonomous driving technologies**: Algorithms, client systems, cloud Platforms	06
2	**Overview of Automotive Electronics**: Control Systems for Autonomous vehicles, Electronic Engine control, Chassis and Powertrain Electronics, Vehicle motion control, Instrumentation and Telematics & ADAS	08
3	**Sensing Technologies** Radar & Sonar, Camera, Lidar, GNSS.GPS/IMU Use of Sensor Data, Sensor Fusion and Kalman Filters	08
4	**Computer Vision and Deep Learning** Computer Vision Fundamentals -Advanced Computer Vision , Neural Networks for Image Processing , TensorFlow ,Convolutional Neural Networks	10
5	**Levels of Automation** Localization - GNSS, LiDAR, Wheel and Visual Odometry, sensor fusion Perception – Detection and Tracking, Driving Perception and deep learning Prediction and Routing- Trffic prediction and Lane level routing Decision, Planning and Control- Motion Planning,Feed back control Cloud System- Operating systems-ROS, Cloud Platforms	12
6	**Connected Car Technology:** Connectivity Fundamentals - DSRC (Direct Short Range Communication), Connectivity types -Vehicle-to-Vehicle, Vehicle-to- Roadside and Vehicle-to-Infrastructure, Vehicle-to-pedestrian, Vehicle- to-clous, Vehicle-to- everything, Applications -Security Issues Technical Issues, Security Issues, Moral and Legal Issues.	08
		52

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Recommended Books:

1. Shaoshan Liu, Liyun Li, "Creating Autonomous Vehicle Systems", Morgan and Claypool Publishers, 2017.
2. Liu, Shaoshan. Engineering autonomous vehicles and robots: the DragonFly modular- based approach. John Wiley & Sons, 2020.
3. Hong Cheng, "Autonomous Intelligent Vehicles: Theory, Algorithms and Implementation", Springer, 2011.
4. Williams. B. Ribbens: "Understanding Automotive Electronics", 7th Edition, Elsevier Inc, 2012.
5. Marcus Maurer, J.Christian Gerdes, "Autonomous Driving: Technical, Legal and Social Aspects", Springer, 2016.
6. Ronald.K.Jurgen, "Autonomous Vehicles for Safer Driving", SAE International, 2013.
7. James Anderson, KalraNidhi, Karlyn Stanly, "Autonomous Vehicle Technology: A Guide for Policymakers", Rand Co, 2014.
8. Lawrence. D. Burns, Chrostopher Shulgan, "Autonomy – The quest to build the driverless car and how it will reshape our world", Harper Collins Publishers, 2018

Course Assessment:

Theory:

ISE-1:	Quizzes (10 Marks), Assignments (10 Marks)
ISE-2:	Assignment (10 Marks), Simulation based problem solving (10 Marks)
MSE:	Two hours of written examination based on 50% syllabus (30 Marks)
ESE:	Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	4	--	--	2	2
HRBSBL701	**Robotics and Automation Lab**	**Examination Scheme**						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	**20**	**--**	**30**	**--**	**50**	

Pre-requisite Course Codes		
Course Outcomes	CO1	Develop simple image processing algorithms
	CO2	Program robots for simple and inverse kinematics and trajectory planning
	CO3	Acquire sensor data over cloud using microcontroller
	CO4	Perform predictive data analysis using clustering, classification and regression models

Sr. No.	Contents	Hours
1	Edge detection / segmentation using image processing	04
2	Programming the robots to solve direct and inverse kinematics problems	04

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3	Trajectory planning for Robots	04
4	Acquisition of sensor data over cloud using microcontroller	04
5	Implementation of Clustering algorithm (K-means / K-medoids)	04
6	Data Classification using data prediction tool (classification tree / artificial neural networks, Support Vector Machines etc.) (Any One)	04
7	Linear Regression using data predictive tool (multiple regression / artificial neural networks etc.) (Any One)	04
8	PLC to operate actuators for automation application	04

Course Assessment:

Laboratory work:

2. **ISE-1 (20 marks)**
   Submission of the observations made during the lab performance for the first 6 experiments covered during this assessment duration. Assessment will be based on pre-defined rubrics.

2. **ISE-2 (30 marks)**
   iii. Submission of the observations made during the lab performance for the last 6 experiments covered during this assessment duration. Assessment will be based on pre-defined rubrics (20 marks).
   iv. Lab interaction: (10 marks)